SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1907.

GENERAL PHYSICS.

1436. *New Recording Rain-gauge.* **L. Palazzo.** (Rivista Meteorico Agraria, Rome, 26. 1906. Zeitschr. Instrumentenk. 27. pp. 202–203, June, 1907.)—The gauge which Fascianelli has made for the Ufficio Centrale di Meteorologia e Geodinamica in Rome resembles a Hellmann ombrograph, but the diameter of the funnel is 357 mm. against 159·6 mm. The level is indicated by a float, and the water passes through two siphons, 6 mm. in diam., to a tilting cup which is placed in a closed box; the water leaving by the discharge pipe thus produces suction in the box and a rapid flow of the water through the siphons. The pen does not record while the siphons are acting. The cylinder makes one revolution a week, and the hour interval has a length of 8·5 mm. H. B.

1437. *Two Heavy Wiechert Seismographs.* (Nature, 76. p. 164, June 13, 1907.)—Critical note on two Wiechert seismographs, made by Spindler and Hoyer, of Göttingen. The "stationary" mass of the horizontal pendulum is 17 tons, the multiplication by four levers 2,200. The instrument is to receive the rapid tremors of small European earthquakes, but would, in the writer's opinion, be too much disturbed by local traffic, &c. The vertical pendulum has a stationary mass of 1,300 kg. and a multiplication of 160. H. B.

1438. *Steadying Device for Ships.* **V. Crémieu.** (Comptes Rendus, 144. pp. 966–969, May 6, 1907. Soc. Franç. Phys., Bull. No. 2. pp. 189–199, 1907.)—The rolling of a ship is always in excess of the slope of the wave at the point of inflection. Owing to the feeble resistance of the keel, the energy of a great number of successive waves accumulates on the vessel. The expression for the maximum amplitude of rolling contains in the denominator the coefficient N of decrease of artificial rolling in calm water. For a normal vessel, N lies between 0·008 and 0·03. It may be raised to 0·05 by lateral keels, or by water ballast in the case of small amplitudes. The author describes a device for bringing up N to any value short of unity. It automatically transforms the kinetic energy of oscillation of the vessel into heat. It consists of a heavy plate oscillating about a horizontal axis parallel to the keel and passing through the metacentre. The plate oscillates in a viscous liquid. Or a channel full of the liquid is bent into an arc of a circle described about the metacentre and is laid athwart the vessel below, with a heavy sphere rolling along it through the liquid. The plate or sphere takes up the rolling impulse, which is frittered away as heat. The author exhibited the model of a mail-boat weighing 18 kg., which when floated in water was brought to rest after two or three oscillations, N being 0·8. E. E. F.

1439. *Units of Mass, Length, and Time.* **H. C. Pocklington.** (Cambridge Phil. Soc., Proc. 14. pp. 152–158, June 18, 1907.)—The object is to find natural fundamental units. Assume the properties of matter to depend on the properties of some ether, simple in character: the properties of matter would be expressible in terms of the fundamental properties of the ether with numerical coefficients, not departing very widely from unity, say from 10 to 0·1. Taking a series of known constants and, for example, assuming atomic volume, which has a mean value of 7, to give us the equation $l^3/m = 7$, and so for the rest, we find these equations best reconciled by new units $l = 4{\cdot}0 \times 10^{-8}$ cm., $m = 1{\cdot}4 \times 10^{-25}$ gm., and $t = 5{\cdot}5 \times 10^{-18}$ sec. There is evidence that there are four fundamental properties of the ether; the granular theory of Reynolds is apparently the only one that satisfies this condition. We can in four ways choose out units of mass, length, and time so as to reduce three out of the four of the numbers expressing these qualities to unity. A. D.

1440. *Diffusion of Metals in Mercury.* **M. v. Wogau.** (Ann. d. Physik, 23. 2. pp. 345–370, June 13, 1907. Extract from Inaug.-Dissertation, Freiburg.) —The author determines the diffusion constants of a number of metals in mercury by the method used by Graham for investigating the diffusion of salts into solvents, the values of the constant, *k*, in sq. cm. per day being as follows :—

	Temp.	*k*.		Temp.	*k*.
Lithium.........	8·2°	0·66	Zinc	11·5°	2·18
Sodium	9·6	0·64	Zinc	99·2	2·90
Potassium......	10·5	0·58	Cadmium	8·7	1·45
Rubidium......	7·3	0·46	Cadmium	99·1	2·96
Caesium	7·3	0·45	Lead	9·4	1·50
Calcium	10·2	0·54	Lead	99·2	1·92
Strontium......	9·4	0·47	Tin..............	10·7	1·58
Barium	7·8	0·52	Thallium	11·5	0·87

The temperature coefficients of the diffusion constants could only be measured for zinc, cadmium, and lead, glass being attacked by amalgams of the other metals at high temperatures. The constants for the alkali and alkaline earth metals and thallium agree with the values calculated on the hypothesis that these metals have monatomic molecules when dissolved in mercury. With zinc, cadmium, lead, and copper, the calculated values are about double the experimental numbers; no explanation of this anomalous behaviour is advanced. T. H. P.

1441. *Spider Thread.* **J. R. Benton.** (Amer. Journ. Sci. 24. pp. 75–78, July, 1907.)—A spider thread of extraordinary length and thickness being available, measurements were made of its physical properties; the thread was 2·5 m. long and 0·01 cm. in diam. The thread was twisted (8 revs. per cm. length) to secure uniformity in diam. and circularity of cross-section. The mean of 5 tests of the tensile strength of the thread showed that a stress of $18 \cdot 0 \times 10^8$ dynes per cm.^{2} was required to produce rupture, which is about double that for most kinds of wood. The thread was found to vary in length irregularly from day to day, the stretching force being constant. This was probably due to the absorption of moisture. The threads showed a decided elastic after-effect, and consequently any value obtained for Young's modulus might involve some arbitrariness depending on the time when the strain is observed. The final value obtained was $8 \cdot 0 \times 10^{10}$ dynes per cm.^{2}. The tensile strength of silk fibres was found by Beaulard [see Abstracts Nos. 875 (1903) and 464 (1904)] to be $2 \cdot 85 \times 10^8$ dynes per cm.^{2} and the value for Young's modulus $6 \cdot 50 \times 10^{10}$, so it seems probable that the material of the spider thread is different from silk. A. W.

1442. *The Hard and Soft States in Ductile Metals.* **G. T. Beilby.** (Roy. Soc., Proc. Ser. A. 79. pp. 463–480, Aug. 2, 1907.)—It has not yet been found practicable to convert a specimen of metal entirely into the hard state by mechanical work. It is suggested that mobile layers formed at intermediate stages in the conversion from soft to hard, permit of much relative movement of more or less unchanged soft (crystalline) masses. The rigidity and tenacity of the hardened metal depend quite as much on the type of structure developed as on the relative proportions in which the soft and hardened forms are present. The temperature-ranges (about 50° for gold and silver) over which recrystallisation, loss of "mechanical stability," development of thermo-e.m.f. between wires in the soft and hardened states, and restoration of elasticity, in mechanically hardened metals occur coincide with one another closely for a given metal, and are well marked, pointing to a true change of state in the hardened metal when a certain temperature is reached. The "mechanical stability" is the stress required to produce a permanent extension of 1 per cent. in the specimen wires. The conception of the hard and soft states is applied in an attempt to explain fatigue. The experiments described upon gold and silver include mechanical tests, transverse vibration, and microscopical examination. The vibration tests showed the partial recovery from overstrain which occurs with lapse of time. [See also Abstract No. 1930 (1906).] F. R.

1443. *Modern Armour and Armour-piercing Projectiles.* **H. J. Jones.** (Engineer, 103. pp. 361–362, April 12; p. 393, April 19; 414–415, April 26, and pp. 442–444, May 3, 1907.)—The author discusses these subjects generally, under the headings—Armour-piercing Projectiles, Caps (for A.P. projectiles), and Theory of Armour. It is pointed out that probably the foundation on which the design of the point of A.P. shell rests needs revision, being merely experiments at 1,500 f.s. striking velocity against unbacked wrought iron and compound plates, the depth of indentation being taken as the relative figure of merit. He finds from experiments in which a heavily loaded punch was dropped on hardened steel plates, that the more highly elastic the plate the more blunt should the nose be, particularly for oblique impact. When the plate is defeated by "boring action," the ratio of diam. of punch to thickness of plate is of great importance; when, however, the plate fails by smashing action, the angle of nose and diam. of punch are less important than the velocity. Combining the Krupp, Davis, Tresidder, and

Vickers (Russian) formulæ, the author suggests for service uncapped A.P. projectiles $t = d^{\frac{1}{2}} v^{\frac{1}{2}}/12000$; and for capped projectiles, $t = d^{\frac{1}{2}} v^{\frac{1}{2}}/10000$; t is the thickness of a hard-faced plate just perforated by the projectile, whose weight is w, diameter d, and striking velocity v. A table of dimensions of armour-plate bolts is given. F. R.

1444. *Distribution of Stresses in Plate-girders.* **C. W. Lloyd-Jones.** (Inst. Civ. Engin., Proc. 168. pp. 189–234, 1906–1907.)—A mathematical investigation of the distribution of stresses in plate-girders, including the stresses in the rivets, with applications to certain relatively simple cases, is given at length, particular account being taken of the effects of riveted joints connecting web and flange. Although the results obtained are mostly not of convenient form for general use, yet it is established that by supporting a uniformly loaded girder with unrestricted ends at points distant d from its ends, where $d = 2{\cdot}3/\surd[(\lambda/R)(1/A_F + 6/A_W)]$ inches, the maximum rivet stress is reduced to about half its value due to max. static shear, and the bending stresses in the web are not sensibly greater than the flange stresses. Here λ is the rivet area per lineal inch of flange, A_F the flange area, A_W the web area, and R a constant, about 4 in. For a beam with a single concentrated load the empirical formula $d = 10 \log 8l$ inches is suggested, where $l =$ half span in feet. The effects of sliding in riveted joints is discussed; it is shown to be detrimental in the case of girders supported at the extreme ends, but not in girders having a sufficient overhang. Its effect is minimised by designing the flanges of as small elements as possible; *e.g.*, the bending stresses in the web of a girder are less if two 12 × ½ in. plates be used than if one 12 × ⅜ in. and one 12 × ⅝ in. be adopted. The paper contains some observations made during inspection of girder bridges. F. R.

1445. *Influence of Stress on Corrosion of Iron.* **Walker** and **C. Hill.** (Mech. Eng. 20. p. 155, Aug. 3, 1907. Paper read before the Amer. Soc. for Testing Materials. Abstract.)—Specimens of Swedish iron were strained in tension whilst forming one electrode in a cell in which the other electrode was normal calomel, and the electrolyte ferrous sulphate. Generally the potential-change below the elastic limit was less than 0·0001 volt, and did not exceed 0·0004 volt. This should have no appreciable effect on corrosion; the strained metal had a slightly less tendency to corrode than the unstrained. Beyond the elastic limit the potential rises suddenly several hundredths of a volt whilst loading, but falls upon unloading. Similar phenomena were observed under torsional stress. Out of a number of specimens strained to rupture, the potentials of six attained a constant value after fracture. The differences between initial and final potentials ranged from 0·0019 to 0·0077 volt. It is concluded that even when strained beyond the elastic limit the corrosion of iron is but little different from the normal. F. R.

1446. *Extensibility of Plain and Reinforced Concrete.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1027–1032, June 29, 1907.)—The author gives detailed results of a number of bending and direct tensile tests of plain and reinforced concretes, from which it is concluded that the concrete *per se* is capable of the same amount of extension in either case. The amount of extension before rupture of plain specimens, and before the opening of hair-cracks in reinforced beams, varies from 0·065 to 0·367 mm. per m. according to mixture and preparation. Concrete which sets under water expands, and concrete setting in the air contracts. Thus in reinforced concrete initial stresses in the reinforcement and concrete are produced, which in the case of water setting are tension in the metal and compression in the concrete; for air setting the signs are reversed. The influence of these stresses upon the extensibility is well marked: *e.g.*, water-set samples showed 0·205 mm. per m. extension, as compared with 0·097 mm. per m. for the same mixture set in the air, and having similar reinforcement. F. R.

1447. *Tests of Concrete Beams and Columns.* **Talbot.** (Eng. News, 58. pp. 30-33, July 11, 1907. Extract from Report, Bulletins 10 and 12 of the Engin. Experiment Station, Univ. of Illinois.)—Gives results of tests of plain and reinforced concrete T-beams and columns of several designs. Beams of flange width of 2, 3, or 4 times the width of web, and having reinforcement equal in area to 1 per cent. of the enclosing rectangle, had the characteristics of rectangular beams, and the critical failure was due to overstrain of the steel, even with steel of 54,000 lbs. per sq. in. yield-point. Wide flanges gave but little added strength at points of max. bending moment, but gave increased stiffness. The vertical stirrups used proved effective web reinforcement. Diagonal tension cracks appeared at or above loads at which failure by diagonal tension may be expected in beams without web reinforcement. In the case of columns, assuming that the stress in the steel is proportional to the deformation of the column, *i.e.*, that there is ample adhesion, the average max. stress in the concrete is found to be 15 per cent. less in the reinforced than in plain columns (1,290 and 1,550 lbs. per sq. in. respectively). The modulus of elasticity at low loads was 2,250,000 lbs. per sq. in.; this is increased by age and decreased by repetition of loading. The ratio of stress taken by steel to stress borne by concrete varied from 12 to 34. The concrete mixtures were 1 : 2 : 4 and 1 : 2 : 3½, and the age 60 to 105 days. F. R.

1448. *Design of Machinery for very High Pressures.* **J. E. Petavel.** (Engineering, 84. pp. 97-98, July 26, 1907.)—Describes with sketches fittings for hydraulic or gas pressure work, suitable for maintaining such pressures as 30,000 lbs. per sq. in., and occasionally reaching as much as 45,000 lbs. per sq. in. Generally a metal-to-metal joint is found essential. For the highest pressures steel tubes were found to be best, as copper after safely withstanding 20,000 to 30,000 lbs. for a week would fail upon reloading at a lower pressure. The steel tubes were jointed thus: the end of one portion was coned, that of the other fitting cupped; the coned end carried a flange which was screwed on and brazed; for the rest the design was that of an ordinary union. Pressures up to 15,000 lbs. were obtained by means of a pump with automatic valves, but for higher pressures a screw-actuated ram, with hand-operated valves, was brought into action. F. R.

1449. *Photo-pitometer and Waterworks Losses.* **E. S. Cole.** (Technology Quarterly, 20. pp. 141-161, June, 1907.)—A paper discussing waste from water mains and the use of the photo-pitometer for investigating such waste. Two Pitot tubes are used in the instrument, one turned up-stream and one down. These are held in a suitable cap, which screws upon a standard 1-in. cock, through which the tubes may readily be introduced into any main and as easily withdrawn. Heavy cloth-insertion rubber tubing connects the orifice tubes with a long glass manometer, and blow-off cocks are provided to remove air from the instrument. The U-tube is half filled with a mixture of carbon tetrachloride and gasoline, having a specific gravity of 1·25, and when in use the water from the pipe fills all the remaining space in the U-tube and connections. The orifices are set to receive the maximum velocity within the main, which is usually near the centre, and is indicated by the deflection in the manometer. This deflection, by virtue of the differential action of the water and the slightly heavier and insoluble liquid, is just four times that due to the actual difference of water head on the orifices, produced by the flowing stream. The orifice turned down-stream gives something less than the static head within the main, thus increasing the pressure-difference produced, so that even a low velocity within the pipe produces a readable deflection. The instrument is reliable at velocities as low as 6 in. per sec. At ordinary velocities the U-tube deflections may run up to 24 in., and therefore need not be read with any great nicety. The photo-recorder consists of a portable box in which a drum carrying Velox paper revolves before a fine vertical slit, just in front of which is locked one leg of the U-tube in such a position that the rays of light from an oil lamp will be partly intercepted on their way through the coloured liquid in the lower half of the manometer. As the liquid rises and falls with the velocity in the pipe, it will record on the Velox paper a line or band of shade whose ordinates vary according to the formula $V = c\sqrt{2gh}$, where h is one quarter of the U-tube deflection in feet, and c, the calibration constant, has been determined to be 0·80. A record of the variation in static pressure is superimposed upon the flow diagram by means of a suitably connected gauge and movable finger, which intercepts the light passing through the U-tube and slot. This pressure record is of great value in the interpretation of any sudden change in the rate of flow, for by its aid we may know whether the observed change in rate is caused by a corresponding variation in pump pressure, or by the change in rate of draught within the district under investigation. A. W.

1450. *Influence of Suspended Particles on Weight and Upthrust.* **B. Löffler.** (Ann. d. Physik, 23. 3. pp. 517–531, July 5, 1907. Extract from Dissertation, Marburg, 1906.)—This question was first taken up by Brücke in 1847 and by Bondy and Mach in 1865. Recently, v. Plessen found a difference in the readings of the areometer and pyknometer in the case of the coarsest suspensions only. In the author's experiments, a brass cylinder, 28·5 gm. weight, was fitted into a glass tube 14·5 cm. long, filled with distilled water, such that the cylinder took about a minute to sink through the water. The glass tube was hung on a delicate balance and its weight observed during the fall of the brass weight. Observations with this and a similar tube show that the brass body becomes heavier at the moment when it experiences a sudden decrease of velocity, and *vice versâ*. In suspensions also, it is inferred, the settling particles transmit their weight-pressure to the liquid so far as their accelerations are neutralised by the friction of the liquid. Sand glasses filled with air or water were also used. To note the effect of sinking particles on the upthrust of a liquid on an immersed body, a weighted cork was caused to sink slowly in the neighbourhood of the immersed body, the weight of the latter being observed during the process. The operation was varied by altering the rate of sinking and also by removing weights from the cork and causing the latter to rise through the liquid. In all cases the sinking cork increased the upthrust, the rising cork diminished it. Further, a sinking plate, and a sieve, perforated at the position of the immersed body, gave similar results. From these experiments it is stated with regard to suspensions, that the single particles fall slowly and with much friction in the liquid; they thus exert pressure on the suspending medium which is forced out through the interspaces. By this means a continuous upward current is set up which, through friction, affects the areometer, causing it to sink to a less degree than it would in pure water. If the suspended particles move upwards, as butter particles in milk, the opposite effect is produced.

G. E. A.

1451. *The Forcing of Oscillations by Disturbances of Different Frequencies.* **A. Stephenson.** (Phil. Mag. 14. pp. 115–122, July, 1907.)—A mathematical inquiry into the joint effect on a system of a force which is a function of the time alone, and a force which is a function of both the time and the configuration of the system. The examination brings out the fact that when the system is sensitive to the disturbance, the oscillation generated is approximately of free period, the system furnishing in certain cases an exception to the rule that forced vibrations follow the period of the exciting cause; reference is made to the case of fluorescence. G. E. A.

1452. *Phenomenon Analogous to Calefaction.* **G. Lippmann.** (Comptes Rendus, 145. pp. 217–218, July 22, 1907.)—If a layer of plaster is spread over a smooth glass plate, allowed to set, and then warmed to over 100° C., the plaster detaches itself from the glass, and as the heating is continued slides over the plate with the greatest ease, the coefficient of friction apparently becoming nil. On cooling, the friction between the plaster and glass reappears. Similar effects are obtained with a brass plate. W. H. Si.

1453. *The Ether and Absolute Motion.* **J. Larmor, C. V. Burton.** (Nature, 76. pp. 269–270, July 18, 1907.)—Referring to the objection to identifying magnetic force with velocity of the ether, which has been discussed by O. W. Richardson, O. Lodge, and others [Abstracts Nos. 958, 959, 1289, 1290, 1292 (1907)], Larmor observes that such a hypothesis involves that the all-pervading ether shall be at rest under normal conditions. An infinitely extended ether postulates absolute motion as a fact in the only real sense of that term, viz., motion relative to the remote quiescent regions of the ether. The point raised by Richardson, that the steady field of a uniformly moving electron would contain an infinite amount of moment of momentum, requires detailed consideration, but it is not without parallel in more familiar departments of abstract physics. For instance, in the case of the steady motion of a solid sphere in infinitely extended viscous fluid, the field of flow around the sphere contains an infinite amount of linear momentum. But this circumstance does not vitiate the dynamics of fluid resistance. In the case of an electron set into steady translatory motion through the ether it is rotational momentum which is steadily imparted to the surrounding ether as time goes on, and is carried away into the distant regions by wave motion. This requires that the ether exerts a torque on the moving electron. Burton remarks that if for the free ether it is assumed that magnetic force is within a constant factor identical with ethereal velocity, then the velocity of the ether at any point can be determined by measuring the magnetic force at that point. For the value of the magnetic force there is a perfectly definite physical criterion, which is independent of any arbitrarily chosen frame of reference, and hence the means would be afforded of determining *absolutely* the velocity of the ether. Thus, on the assumption, absolute motion attains to a definite physical significance which has no counterpart in the postulates of ordinary dynamics, and, this being so, dynamics must fail to give a true account of electromagnetism. Thus, if the magnetic vector be identified with translational ethereal velocity, and at the same time it is assumed that a dynamical system is being dealt with, results inconsistent with known electromagnetic relations may be expected.

J. J. S.

1454. *Influence of Wind on the Quantity of Rain collected in a Rain-gauge.* **A. Lo Surdo.** (N. Cimento, 13. pp. 519–524, June, 1907.)—Experiments with an apparatus in which comparison could be made between the amounts of rain collected in gauges travelling (1) in the same direction as the wind, (2) in the opposite direction, and (3) in another direction, show that, as was to be expected, the quantity collected by the first is greatest, and by the second least. The ideal gauge should move with a velocity equal to that of the wind, and in the same direction; but the apparatus described cannot be made to fulfil these conditions. W. H. St.

1455. *Uplift increases Rainfall, Denudation diminishes it.* **M. S. W. Jefferson.** (Science, 25. pp. 909–910, June 7, 1907.)—As the mountains, even when flat, receive more rain and snow than low levels, Kassner has pointed out in Petermann that rainfalls must have been greater before erosion levelled the country, and that denudation tends to produce diminution of precipitation. Regional uplift has, however, the opposite effect. The Black Hills of South Dakota have more rainfall than the region about, because of the domed uplift of the region above the plains. But although more than 8,000 ft. may have been removed from their summits since this uplift, the hills may never have been more than 700 ft. above sea-level, as denudation counteracted the upward thrust. There would then not be any diminution in rainfall. H. B.

1456. *Velocity of Centres of High and Low Pressure in the United States.* **C. F. v. Herrmann.** (Monthly Weather Rev. 35. pp. 169–171, April, 1907.)—The paper exhibits, in tabular form, the mean velocities and total number of centres of areas of low and high pressure for each month. The results are calculated from the material supplied by the "Monthly Weather Review," for the periods 1878–1904 in the case of low pressures, and 1888–1904 in the case of high. A comparison with Loomis's averages for 1872–1884 shows substantial agreement. The mean rate of progress of cyclone centres is much greater in the United States than over the Atlantic or Western Europe. The rates are: United States, 28·6 miles an hour; Atlantic, 18·1; Western Europe, 16·8 (Hann). The explanation is that in Continental America the air contains far less moisture than it does over the Atlantic or Western Europe, and consequently the point of condensation where the maximum storm formation occurs must lie at a higher level over the broad continent. In winter there is even less moisture in the air, and so the region of maximum disturbance is elevated and the velocity of storms increased. The ratio of the means of the summer and winter velocities is about 24 to 25. The general eastward motion of the atmosphere increases upward from the earth's surface. Ferrel gives it as about 26 miles per hour at an elevation of 2¼ miles, and it must be considerably greater at the elevation of 3 or 4 miles at which, according to Bigelow, the maximum development of cyclones takes place. A velocity for individual depressions of 60 miles per hour or more has been observed in the United States 15 times during the past 26 years.

The following are the highest velocities, in miles per hour: 81 (Feb., 1884), 79 (Dec., 1884), 75 (on 8 occasions). These being average velocities, the actual speed at times was doubtless greater. In some cases the velocity of the spirally inflowing winds must actually have been less than the movement of the disturbance as a whole. The maximum velocities known for Europe are 76 miles an hour (Hamburg, March, 1876), 70 miles an hour (1869 and 1875). The values for the average velocity of anticyclones are not so certain, on account of the difficulty of fixing exactly the centres of high-pressure areas. The annual mean is 25·6 miles an hour, which is only 10 per cent. less than the speed of cyclones. The maximum monthly mean is in Jan., 29·5 miles, and the minimum in Aug., 22·1 miles. The maximum velocity of anticyclones rarely exceeds 60 miles an hour. A. E.

1457. *Weather Forecasting by Analysis of Atmospheric Conditions into Waves of different Lengths.* **H. H. Clayton.** (Monthly Weather Rev. 35. pp. 161–167, April, 1907.)—Resuming studies of 1885, the author points out that the study of the drift of the weather conditions is the most promising line of research, and he arrives at the following conclusions: (1) Every meteorological element at any given place may be analysed into a definite number of oscillations or waves differing in length, each of which appears to have a physical existence distinct from that of the others. (2) When analysed in the same way, for any given time, the data at widely separated stations show analogous waves, except that the maxima and minima differ somewhat in the time of occurrence at the different stations. (3) The waves, at least in temperate latitudes, drift generally from west to east. (4) The velocity of drift is inversely proportional to the wave-length. Fluctuations or oscillations completed in a short period of time drift rapidly, while longer fluctuations drift more slowly. (5) The speed of travel appears to be fairly constant from year to year. H. B.

1458. *Winter Waterspout on Lake Erie.* **D. Cuthbertson.** (Monthly Weather Rev. 35. pp. 73–74, Feb., 1907.)—On Feb. 11, 1907, a funnel-shaped cloud formed over the Buffalo corner of Lake Erie, where the Niagara River emerges. The lake was covered with ice and snow, but that portion was free from ice owing to the rapid current. The column formed over the extreme end of the open water and travelled across the ice, clearing it of snow, towards the shore, near which it vanished. The column moved in the direction of the surface wind, which was blowing from N.E. at the rate of 36 miles an hour. H. B.

1459. *Gorges in the Sea and Vulcanism.* **E. A. Martel.** (Comptes Rendus, 144. pp. 1468–1470, June 24, 1907.)—Mercalli having in his "Vulcani Attivi" again drawn attention to the intervention of infiltrated sea-water in volcanic eruptions, the author refers to the sea-mills at Argostoli, Cephalonia (Ionian Islands), where sea-water rushes into the calcareous shore. The phenomenon is by no means unique, and it seems likely that the sea-bottom contains gorges in which water disappears to rise again as thermal springs and to cause volcanic reactions. H. B.

1460. *Mexican Earthquake of April 15, 1907, and Notes on the Movements induced by Earthquakes.* **C. F. Marvin.** (Monthly Weather Rev. 35. pp. 157–159, April, 1907.)—After the Jamaica earthquake of Jan. 14, 1907, the Weather Bureau seismographs did not record any movements of noticeable magnitude until the Mexican earthquake of April 15 which destroyed Chilpancingo, Chilapa, and Ayutla. The origin at lat. 17·5° N., and long. 99·5° W. lies to the south-west of Washington, and the records of the north-south and east-west components resembled each other. The author gives particulars and discusses the nature of earthquake records, and of the motions of the seismograph pier. H. B.

1461. *Earthquake Fissures and Scarps.* (Science, 26. pp. 90–93, July 19, 1907.)—In his essay "On some Principles of Seismic Geology" (Beitr. zur Geophysik, pp. 219–292, 1907), W. H. Hobbs describes 81 examples of fissures and scarps due to earthquakes. These examples do not, in the author's opinion, support the "lineaments" of Hobbs, who connects points where earthquakes have been recorded by straight lines which are to supply some seismotectonic information. The writer distinguishes between "fault scarps" which directly measure differential displacement in altitude and length and which always face from the heaved to the thrown block, and "fault-line scarps" in which the original displacement has been base-levelled in a completed cycle of erosion, so that we can no longer recognise the altitude and length of the displacement, and which face the weaker rock. He further discusses the fault-line scarps and erosion valleys of Central Sweden after Gunnar Andersson and A. Larsson, the Pennsylvanian Alleghanies, and the Hurricane Ledge of Arizona from the physiographic standpoint. H. B.

1462. *The Depression in the Total Intensity of the Solar Radiation in* 1903 *as measured at Warsaw.* **L. Gorczyński.** (Monthly Weather Rev. 35. pp. 171–175, April, 1907.)—A portion of the article is devoted to pointing out an important source of error in the old theory of the Ångström-Chwolson actinometer. The mistake consists, as recent results show, in the inadequacy of converting actinometric measures by means of an instrumental "constant." The writer shows that the supposed constant is variable in the course of the year. The variations correspond approximately to those of the intensity of the solar radiation. The instrument in question is one of the "dynamic" type, the essential point of the method employed consisting in the simultaneous measurement of the differences of temperature between two identical bodies, one in the sunlight the other in the shade. A former provisional note of the author's [see Abstract No. 991 (1904)] contained numerical results which were affected by the above error. The corrected results are included in a work published in 1906 ["Sur la marche annuelle de l'intensité du rayonnement solaire à Varsovie, &c.," Wende and Co., Warsaw]. Investigations in which the error was allowed for show that the actinometer constructed by O. Chwolson is entitled to rank among instruments of precision. The author compares the annual and monthly means of the intensity of radiation for the years 1901–1905 at Warsaw. His diagram shows markedly the strong diminution which occurred in 1903, when the annual mean was less by nearly 20 per cent. than in 1901, and less by 15 per cent. than the average of the 5 years. This marked diminution, which extended from Dec., 1902 to Feb., 1904, was not of a character local to Poland, having been observed in other parts of Europe and in America. The annual march of intensity was also abnormal during that period. As a rule, this annual march at Warsaw presents 3 maxima, viz., (*a*) principal maximum in spring, in April or May; (*b*) second maximum in summer, in July; (*c*) third maximum in autumn, in Sept. The minimum occurs in

Dec. or Jan. But in 1903 the intensity was about 20 per cent. below the normal at the beginning and end of the year, while in June it was relatively quite high. The intensity curve for the year almost resembles a single peak, the only dip being in May, following a faint indication of the usual spring maximum. The great depression both started and departed abruptly. Thus, Feb., 1904, gives values diminished by more than 80 per cent., and yet the depression ends the same month. This profound perturbation may have given rise to important meteorological results. The author limits himself in this respect to indicating the amounts of insolation and heat at Warsaw for the three years 1903, 1904, 1905. In 1903, the duration of sunshine was 85 per cent. of the maximum possible; in 1904, 50 per cent.; in 1905, 44 per cent. The amounts of heat for the 3 years were in the proportion of 85, 51, 48.

A. E.

1463. *Sun-spots.* **C. Barus.** (Science, 25. pp. 972–973, June 21, 1907.)— A possible analogy between geyser-like action and periodic solar disturbance is suggested. Let a curve *td* represent the relation between temperature and depth below the solar surface. Let another curve *tp*, on the same diagram, represent the relation between temperature and depth which is the condition for transition from an atomic form A to an atomic form B. Then the transition will occur at depths below the solar surface given by the ordinates of the points of intersection of the two curves *td* and *tp*. Suppose, as a first alternative, that after a sun-spot period the *td* line has been depressed by the sudden cooling of all active strata to a position *t′d′* completely below *tp*. The points of intersection have vanished. B matter only is present. In the lapse of time, however, owing to heat arriving from below, the line *t′d′* again rises until it intersects *tp*, when another eruption occurs, which drops the *td* line to *t′d′* in turn. The depression of this line is relatively sudden; its gradual rise, together with the properties of the AB system, determines the frequency of the sun-spot period: the element A escapes (let us say) in gaseous form. The relations of the curves *td* and *tp* will vary with the solar latitude; on passing from pole to equator *tp* shifts bodily from left to right (depth being supposed represented by abscissæ). At the poles A may thus be permanently absent, while at the equator *t′d′* may never fall below *tp*. Hence an intermediate sun-spot zone may be inferred. As a second alternative, the transition of A into B may be supposed a source of heat, and the ensuing 11 years an interval of cooling, the cycle of changes being reversed.

A. E.

1464. *Heliomicrometer.* **G. E. Hale.** (Astrophys. Journ. 25. pp. 293–299, June, 1907. Contribution from the Solar Observatory, No. 16.)— Measurements of solar photographs have hitherto been made chiefly by means of a machine giving polar co-ordinates from the sun's centre as origin, and it is necessary to undertake considerable labour in computation before the latitudes and longitudes of the points required are determined. The method is satisfactory, however, so long as the positions of only few points are needed. In the new problem presented by the spectroheliograms obtained by photographs in monochromatic light the number of features to be measured becomes very much greater, and to meet these requirements the author has devised an instrument which he calls the Heliomicrometer, by means of which the positions are determined directly by inspection. Two instruments have been constructed in the course of the investigation. In the first a globe having a whitened surface was arranged so that an image of the solar surface from a photograph could be projected on it. The axis of the globe being set at the proper inclination for the date of the photograph, and the plate properly oriented, it is only necessary to read off the heliographic latitudes of the flocculi and their longitudes from the sun's centre by means of circles ruled on the surface of the globe. It is essential that the angular diam. of the globe, as seen from the projecting lens, shall equal the angular diam. of the sun, as seen from the earth. In a later instrument two projecting lenses were employed; one projected the image of the globe, the other that of the solar photograph, and by means of a reflecting prism the two images were brought together in a single eyepiece. The difficulty of seeing faint flocculi on the brightly illuminated surface led to the use of cross-wires for setting, and in place of the circles ruled on the globe two setting circles were attached, so that when the cross-wire was adjusted over any flocculus, say, the devided circles gave the amount by which the globe had been rotated from the zero position. The images were again combined in one eyepiece by a prism. Measurements are confined to objects within 50 degrees of the sun's centre, for the purpose of avoiding errors inevitable when spots or flocculi are measured in the near neighbourhood of the sun's limb. Comparative tests of the accuracy of measurements made with the heliomicrometer and by an ordinary machine giving polar co-ordinates showed that the latitudes and longitudes of the flocculi measured in the two ways agreed within one or two tenths of a degree—about the limit of error in setting. C. P. B.

1465. *Spectra of Limb and Centre of Sun.* **G. E. Hale** and **W. S. Adams.** (Astrophys. Journ. 25. pp. 300–310, June, 1907. Contribution from the Solar Observatory, No. 17.)—Prior to 1873 no differences in the relative intensities of the Fraunhofer lines at the centre of the sun's disc and the limb had been detected. In that year Hastings observed evidence of change, and repeated the investigation in 1879–80 with improved apparatus. Hastings noted that at the limb the spectrum lines usually seen with hazy wings were deprived of them; that certain lines were intensified while others were weakened. At the Solar Observatory on Mount Wilson photographs have been taken with the snow telescope, in which a solar image 6·7 in. (17·02 cm.) in diam. was projected on the slit of a Littrow spectrograph of 18 ft. focus. Most of the spectra were taken in the third order of a plane Rowland grating. The image was adjusted so that the slit was about 1 mm. within the limb, and after this was photographed the spectrum of the centre was taken alongside by means of a comparison bar on the slit plate. Examples of the photographs are given in the paper, showing the reduction of the winged lines—a feature which is opposite to that produced by spots. When we come to examine the changes in many of the sharper lines, however, it is evident that there is a general similarity between the spot spectrum and the limb spectrum, both as to lines strengthened and weakened. It is noticeable that the spark or enhanced lines show a general tendency to be weakened at the limb. In considering the behaviour of the lines of different elements an interesting peculiarity is that while in the spot spectrum the lines of Ti and V are very conspicuous, it is the lines of such elements as Fe, Mn, Ca, &c., which are relatively more affected at the limb. The hydrogen lines present an apparent anomaly. The wings of H_γ and H_δ are reduced at the limb, in common with those of Ca, &c., but the red line H_α appears to be decidedly widened and possibly strengthened. C. P. B.

1466. *New Applications of the Spectroheliograph.* **G. E. Hale.** (Astrophys. Journ. 25. pp. 311–314, June, 1907. Contribution from the Solar Observatory, No. 18.)—(1) *Solar photography with sun-spot lines.*—A large spectroheliograph has been constructed with camera about 30 ft. focus, and by the use of a large plane Rowland grating, giving very great dispersion, it is proposed to make spectroheliographic pictures of the sun's surface in monochromatic light known to be special to sun-spots. The preliminary experiments are sufficient to show the importance of the method, as many points of difference from the ordinary photographs are brought out. These pictures show the umbra and penumbra darker than the plates taken with light of the adjoining continuous spectrum, and the apparent diam. of a spot also appears to be increased, doubtless owing to the inclusion of the dark area surrounding it. (2) *Stereoscopic pictures of the sun.*—Photographs taken with the spectroheliograph at suitable intervals have been combined in the stereocomparator, and it is found by this means it is much easier to detect certain types of minute change than by the usual comparison area by area of two separate plates. Generally, of course, the changes in the forms of the flocculi are noticeable, but do not prevent a fairly satisfactory combination of the two images. The sphericity of the sun and the protuberant character and cloud-like aspect of the flocculous masses are well shown. C. P. B.

1467. *Interpretation of the so-called Canals of Mars.* **S. Newcomb.** (Astrophys. Journ. 26. pp. 1–17, July, 1907.)—The author begins by summarising data and formulæ relating to telescopic aberration, with special application to the subject under discussion. He deduces that even with the best refracting telescope we cannot expect in practice to bring more than one-fourth the light of a star within a circle of radius 0·10 in. In the image of a star the dispersed light diminishes rapidly as we go out from the centre; but in the image of a bright line the diminution will evidently be much less rapid, since a point near the line will receive dispersed light from many points in the line. In the case of a black line or band observed against a bright background, the band will be partly illuminated by spreading of light from the bright edges which will be correspondingly dimmed. The effect will be to greatly widen the dark band at the cost of its blackness, and to render its borders indefinite. In discussing the psychological side of the question, it is to be noted that the eye does not perceive what is actually pictured on the retina, but unconsciously introduces a correction based on general experience. We have here a possible source of error, inasmuch as experience may prompt us to apply such correction to cases where the conclusion would be illusory. The process of visual inference plays a more important part as the object approaches the limit of visibility. The author has made experiments on the visual interpretation of dark lines on a white background, his method being to observe broken lines, drawn in ink, on paper placed against a window. At a certain distance the broken lines appeared uniform and continuous. Seen somewhat nearer the lines presented a blotched appearance. Drawings by Barnard, W. H. Pickering, and Bailey, the results of similar experiments made at the author's request, are reproduced; and it is suggested that experiments by other skilled observers, to test their own eyes, would be valuable. In one case the author saw lines on a paper he knew to be blank, the illusion being due to small irregularities of shade in the tissue. The article concludes with an attempt to calculate the area of Mars which would be covered by Lowell's canal system. Taking into account the facts that the canals are probably not black, and that the planet's surface is not uniform, he finds for the breadth of the narrowest visible canal 10 to 20 miles. To this must be added a border of 20 miles on each side, produced by aberration, diffraction, and atmospheric softening. Assuming 400 canals of mean length 1,500 miles, and mean breadth 55 miles, we have 33,000,000 square miles for the apparent area of the system as depicted on the retina. The total surface of Mars is about 55,000,000 square miles. A. E.

1468. *Mars. Duplication of Solis Locus.* **P. Lowell.** (Lowell Observatory, Bull., No. 28. Nature, 76. p. 258, July 11, 1907.)—Lowell records that the Solis Locus showed double on May 18, being the first time it has appeared divided since the summer of 1894. It is not a case of gemination, as the two portions are not alike either in shape or size, nor were they in 1894. Along the canals which emerge from the eastern part, a new one was detected for the first time on May 18, and has received the name Ichor. The south polar cap has retreated southward, leaving dark ground behind it, and it is noticed that the canals connecting the Solis Locus on the south are darker and more easily visible than those proceeding from it on the north, although the tilt of the planet's axis should render the former more difficult of detection. From the appearance of the dark ground Lowell argues that water, and not carbon dioxide, is concerned. It would follow from this that the temperature in this region, latitude 42°–52°, was already higher than 0° C. on May 18.
C. P. B.

1469. *Venus as a Luminous Ring.* **H. N. Russell** and **Z. Daniel.** (Astrophys. Journ. 26. pp. 69–70, July, 1907.)—This rare phase of Venus was observed in 1898, and again at the conjunction of 1906. On Nov. 29, 5h. 7m. G.M.T., the planet was observed with the 5-in. finder of the 23-in. telescope at Princeton, U.S.A. It was then about 1° 49′ from the sun. When the complete circle was visible the space within it always appeared a shade darker than that without, but it is likely that this was subjective. The extent of the crescent was measured with a filar micrometer on Nov. 27 and Dec. 4, and the value of the twilight arc in the planet's atmosphere found to be 58′ on Nov. 27, > 62′ on Nov. 29, agreeing fairly well with the mean value of 70′ determined from the 1898 observations. The ring phase of Venus may perhaps be seen again in 1914 if the atmospheric conditions are very favourable, after that there will be no further opportunity until 1972. C. P. B.

1470. *Spectrum of α Orionis.* **H. F. Newall** and **B. Cookson.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 482–486, May, 1907.)—In photographs of the red end of the spectrum of α Orionis the authors have detected three strong dark flutings, with heads towards the blue, which are apparently identical with three flutings which Hale and Adams found in the spectrum of sun-spots, and identified as reversals of the bright flutings at the red end of the spectrum of the flame of the titanium arc. The observation is of interest in connection with Hale's discovery of the close resemblance between the spectra of sun-spots and of α Orionis, both having certain lines intensified relatively to the solar lines. The second section of the paper contains a list of wave-lengths of lines in the green region of the spectrum of α Orionis, between λ5099 and λ5621, from photographic measures. Side by side with it is printed a list of sun-spot lines published by Hale and Adams, and comparison shows that a large number of the green lines in the star are also spot lines. It is further mentioned that the authors have identified on their photographs all but 3 of the 25 lines in the spectrum of α Orionis, between λ5393–5703, whose wave-lengths also have been published by Hale and Adams. The 3 lines not identified are 5393·38, 5407·62, 5418·99. The first is a doubtful spot line, the second much intensified in spots, and the third not intensified. According to Hale, the first two are strong lines in the star, and their absence is therefore remarkable, suggesting the possibility of change in the star's spectrum. The authors have also measured in α Orionis the wave-lengths of two absorption flutings, sharp on the violet side, with their heads at 5166·8 and 5447·1, which they ascribe to titanium. Of the five other titanium flutings, however, which belong to this region, no certain indication has been found in the spectrum of α Orionis, though they are all present in *o* Ceti. A. E.

1471. *Spectrographic Study of the Fourth-class Variable Stars Y Ophiuchi and T Vulpeculæ.* **S. Albrecht.** (Astrophys. Journ. 25. pp. 330–348, June, 1907.)—At present, investigations of radial velocities of stars are made chiefly with three-prism spectrographs, the practicable limit of which is about the sixth stellar magnitude. The present investigation was undertaken partly to test the usefulness of the one-prism spectrograph, with which much fainter stars can be reached, and partly to investigate the peculiarities of short-period variable stars of the *δ Cephei* or *η Aquilæ* type. The telescope employed was the 36-in. Lick refractor, with the one-prism spectrograph attached. With this combination a radial velocity of 20 km. per sec. is equivalent to a shift of 0·005 mm. (0·0002 in.). The results obtained were considered highly satisfactory, and the following conclusions were drawn from them: (1) It was proved that radial velocities of stars of the eighth photographic magnitude can be obtained with exposures of three hours, provided their spectra contain well-defined lines. (2) For several variables of the *δ Cephei* type it was found that the point of maximum energy in the spectrum shifts towards the violet as light maximum is approached, and back again towards the red as the brightness diminishes. The effect usually appears as a considerable intensification of the region λ4000–4200, which then seems stronger than the H_γ region. Whether this shift occurs with absolute regularity could not be decided. (3) On these low-dispersion spectrograms no periodic shift in the position of any individual lines (blends) was found. Irregular shifts, as yet unexplained, were noticed. (4) Velocity curves and orbits for *Y Ophiuchi* and *T Vulpeculæ* were obtained. For *Y Ophiuchi* (mag. 6·2 to 7·0, Chandler) the author finds a period U = 17·121 days, maximum velocity K = 8·5 km., velocity V of system = 5·0 km. For *T Vulpeculæ*, U = 4·436 days, K = + 17·6 km., V = −1·3 km. (5) A comparison of light and velocity curves of 10 variables of this class showed a much closer relation to exist between the light- and velocity-variations than has been suspected. In every case the interval between maximum light and greatest velocity of approach is small and less than 1/15 of the period. Likewise minimum brightness and greatest velocity of recession occur at nearly the same time. The curves of brightness and velocity are closely similar in phase, shape, and period. The time interval from maximum to minimum brightness is, on an average, about double the interval from minimum to maximum. At present, the best theory for this class of variables seems to be that they are binaries in which one star is much brighter than the other. The observed velocity-variation is due to the orbital motion of the brighter component. The light-variation cannot be caused by eclipse, for in that case maximum and minimum brightness should occur where the velocity relative to the earth is zero. The facts stated above under (5) would indicate that the light-variation is dependent upon the direction from which the star is observed. The darker companion may be influential in liberating an unusual amount of energy at a certain part of the orbit, most probably just after periastron. But the Algol variables, which have an even shorter average period than the *δ Cephei* variables, show no evidence of mutual disturbance, nor of variation other than that caused by eclipse. Most of the Algol variables, however, have simpler or earlier type spectra (B, A, F) than the variables of Class IV. It is possible that in close binaries of simple type the mutual disturbances may have less effect on the light than in those of more complex type. A. E.

1472. *Presence of Tin in Stellar Atmospheres.* **J. Lunt.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 487–488, May, 1907.)—The author has found evidence of the presence of tin in the atmosphere of α Scorpii, from examination of photographs taken with the 4-prism spectrograph of the Royal Observatory at the Cape. His attention was drawn by Goatcher, who was engaged in measurements of stellar radial velocities, to the fact that a certain line at λ4525 gave markedly discordant results when assumed to be a blend of two lines in Rowland's tables at 4525·110, Intensity 0, origin unknown, and 4525·814 Int. 5, due to iron. The author's explanation of the discordance is that there is a strong tin line at 4525, which is present in the star's spectrum, and forms part of the blend. Measurements of photographs of the spectrum of tin gave 4525·01 as the wave-length of the line in question, showing that it is more likely to coincide with Rowland's solar line, 4525·009 Int. 0, than with the line closer to the iron line, viz., 4525·110 Int. 0. The assumption that the Sn and Fe lines have intensities 3 and 4 in α Scorpii instead of 00 and 5 as in the sun, and wave-lengths 4525·009 and 4525·814, well represents the stellar line. Photographs of the Sn and Fe spectra, which were taken on one plate in the laboratory, show the blended lines as a single broad line, just as in the stellar spectrum. The author's evidence for the presence of tin in the star depends on a single line, the above-mentioned line at 4525·01 being the only strong tin line in the limited spectral region covered by the Cape 4-prism spectrograph which is likely to occur in the cooler stars such as α Scorpii. The spectrum of tin contains another line at 4585·80, but it is an enhanced line, and hence unlikely to be present in a cooler star. The author therefore suggests that further confirmation of the existence of tin in stars should be looked for outside the region of the spectrum available with the apparatus at his command, particularly in the direction of longer wave-length. Hale and Adams have secured with the Snow telescope a spectrum of α Orionis extending to λ5703·78. It will be of interest to learn whether the yellow arc line of tin at 5631·91 is shown in their photograph. It occurs in a region of the solar spectrum free from strong lines. In the Harvard Annals a line is recorded at 5632·0 as being stronger in α Orionis than in the sun, Capella, or α Boötis. The recorded evidence of the presence of tin in the sun appears to be meagre and doubtful. The star line at 4525 has been used in radial velocity determinations by Frost in β Leporis, and by Bélopolsky in γ Cephei, and in both these cases also the line gave a lower result than any other on the plate.

A. E.

1473. *Positions of Eros Comparison Stars deduced from the Toulouse Photographs.* **B. Baillaud.** (Comptes Rendus, 144. pp. 1143–1146, May 27, 1907.)—In discussing the positions of stars in connection with the determination of the solar parallax from the planet Eros, Hinks found certain systematic errors both in right ascension and declination. The author, assisted by Bourget, is investigating the cause so far as the Toulouse plates are concerned. Hinks pointed out that when the Toulouse measures were reduced by Turner's method the discrepancies disappeared. The method of reduction previously employed, based on formulæ due to P. and Pr. Henry, neglects errors of centreing of the plate and its perpendicularity to the optic axis. An examination of the Toulouse instrument revealed a slight error in centreing sufficient to affect terms of the first order in the reduction formulæ. On investigating the effect of this on the reductions certain questions arose which will require further discussion. For a reason not fully explained, it has been found necessary, in determining the plate elements, to separate the equations arising from the right ascensions and declinations. The magnitude equations discovered by Hinks are confirmed by the author's calculations, though slightly smaller numerical values were obtained, the signs, however, being the same. The author finds that, to reduce stars of magnitude $7{\cdot}5 + m$ to the 7·5 mag. standard the α's must be increased by $m \times (0{\cdot}005\mathrm{s.})$ and the δ's by $m \times (0{\cdot}06'')$. The calculations required for the paper were performed by Mdlle. Vaudein, of the Bureau des mesures. A. E.

REFERENCES.

1474. *Effect of Rotatory Inertia on the Vibrations of Bars.* **J. H. C. Searle.** (Phil. Mag. 14. pp. 35–60, July, 1907.)—A mathematical treatment.

1475. *The Structure of Metals.* **J. A. Ewing.** (Manchester Lit. and Phil. Soc., Mem. 51. 15. pp. 1–20, July 30, 1907. Wilde Lecture.)—Elaborates a theory of the constitution of crystals of metals, in which the elementary particles are supposed to have polarity in the directions of three rectangular axes, this being of a somewhat similar nature to magnetic polarity, but independent of the magnetic quality, if any, of the metal. This view permits explanations of many of the known properties of metals under stress, including elasticity and elastic limit, plasticity, recovery from overstrain, and fatigue. [See also Abstract No. 1681 (1906).] F. R.

1476. *Measurement of Surface Tension.* **C. T. R. Wilson.** (Cambridge Phil. Soc., Proc. 14. p. 206, June 13, 1907.)—A method of ascertaining the curvature of a surface of mercury, made to serve as a convex mirror, by means of a microscope. If the pressure be changed by a known amount between two such measurements of curvature we can deduce the surface tension, for $2T(1/r_1 - 1/r_2) = p_1 - p_2$. A. D.

1477. *Formation of Fog.* **E. Barkow.** (Ann. d. Physik, 23. 2. pp. 317–344, June 13, 1907. From Dissertation, Marburg, 1906.)—A summary is given of various researches on the formation of fog in the case of water vapour and some other vapours. A brief account is given of the observations of previous investigators as well as those made by the author. The researches referred to include the action of an alternating electric field, Röntgen rays, ultra-violet light, an electric point-discharge, the electric spark, radio-active substances, as well as the behaviour of ozone, of compounds of oxygen and sulphur, and of H_2O_2 in forming mist or fog in water vapour. Various forms of fog—homogeneous and inhomogeneous—and blue fog are also discussed, and the formation of fog in the case of other gases and vapours such as benzol in hydrogen and carbon disulphide in hydrogen is shortly referred to. J. J. S.

1478. *Flow of Gases and Liquids through Ring-shaped Crevices.* **E. Becker.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1133–1141, July 20, 1907. Extract.)—The author first treats the subject mathematically in the light of Poiseuille's results for the resistance to streaming of fluids through capillary tubes. Experiments were undertaken with special apparatus, two forms being used, one a simple hollow cylinder 22·04 mm. diam. nearly closed by a coaxial solid cylinder 20·8 or 21·2 mm. diam.; the other was a five-step labyrinth. Numerous tables of results are given, for which see original paper. A. W.

1479. *Fundamental Formulæ for the Dynamics of Isotropic Media.* **C. Somigliana.** (Accad. Sci. Torino, Atti, 42. 11. pp. 387–401, 1906–1907.)—The paper is entirely mathematical and continues the work of a previous paper [see Abstract No. 862 (1906)]. S. G. S.

1480. *Dynamics of Moving Systems.* **M. Planck.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 29. pp. 542–570, 1907.)—A highly analytical paper which deals with the dynamics of moving systems on the principle of relativity. After the introduction it deals with (1) The dynamics of black radiation in a moving hollow space, (2) The principle of least action and the principle of relativity, (3) Applications, and (4) Introduction of new independent variables. E. H. B.

1481. *Rainfall and Run-off of the Catskill Mountain Region.* **T. Merriman.** (Monthly Weather Rev. 35. pp. 109–118, March, 1907.)—The author examines the records of 76 stations, a few kept for more than seventy years and together covering a period of 1,085 years, in order to determine the rainfall on each of the four watersheds of the region, and with the particular object of determining the percentage of rainfall available for the additional water supply of the city of New York. H. B.

1482. *Activity of Mount Etna.* **A. Riccò.** (Comptes Rendus, 145. pp. 289–291, July 22, 1907.)—The number of recorded eruptions of Etna is 138. But it is only since 1759 that we have complete lists, and the data do not suffice to establish any connection between the eruptions and the rainfall, the distance of the sun, and the distance of the moon; the latter question has been studied by E. Millosevich. Although the crater is emitting smoke at present, there has been no real eruption since 1892—an unusually long period of comparative quietness. H. B.

1483. *Publication of Equatorial Observations, and a Means of Improvement.* **G. Bigourdan.** (Comptes Rendus, 144. pp. 1314–1318, June 17, 1907.)—The actual observations, consisting in general of measured differences of interval between the required star and a known comparison star, are usually published in conjunction with the concluded places. The author, however, points out that it is not customary to provide data for determining any error which may arise from defective orientation of the micrometer. He suggests that the adopted reading for the direction of daily motion should be published, together with facilities for evaluating the error of this reading, and describes a process for carrying out his suggestion. The practical part of the process need not be performed at the time of actual observation. A. E.

1484. *Orbit of Spectroscopic Double β Arietis.* **H. Ludendorff.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 22. pp. 418–426, 1907. Astrophys. Journ. 25. pp. 320–329, June, 1907. Translation.)—Determination of the elements of the orbit from reductions of 76 spectrograms obtained from 1902 to 1907. The period is 107 days. [See Abstract No. 1688 (1906).] C. P. B.

1485. *Range in Maximum Brightness of Long-period Variables.* **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 489–491, May, 1907.)—Following up an idea that the observed range in brightness at maximum of many long-period variables may be due to the aspect of presentation of the axis of the star to the earth, comparative tables have been made of Chandler's variable star lists. From this comparison it appears that the polar-view stars show less range at maximum than the equatorial-view stars, this being apparently in contradiction of the hypothesis. C. P. B.

1486. *Orbit of Spectroscopic Binary* κ *Cancri.* **N. Ichinohe.** (Astrophys. Journ. 25. pp. 315–319, June, 1907.)

1487. *Orbit of* α *Centauri.* **Doberck.** (Astronom. Nachr., No. 4189. p. 209, July 6, 1907. Nature, 76. pp. 280–281, July 18, 1907.)—The orbit of α Centauri has been reinvestigated, the period now being given as 78·81 years. C. P. B.

1488. *Variable Stars.* **Müller** and **Kempf, Luizet.** (Astronom. Nachr., No. 4186. June 28, 1907. Nature, 76. p. 258–259, July 11, 1907.)—*X Persei.*—Müller and Kempf give observations of this peculiar variable which have been continued for about twenty years at the Potsdam Observatory; the paper gives a light curve from the observations made during the period 1899 to present time. *o Ceti, R Leonis, S Coronæ.*—Luizet gives data as to maxima and minima of these long-period variables. C. P. B.

1489. *Short-period Variable Star.* **J. Metcalf.** (Astronom. Nachr., No. 4191. p. 260, July 23, 1907. Nature, 76. p. 337, Aug. 1, 1907.)—A star having the position RA $= 9^h\ 45^m\ 39^s{\cdot}8$; Decl. $= +12^\circ\ 20'{\cdot}3$ (1900·0) has been found to change its magnitude from 13·5 to 11·5 in a period of about four days. This range of variability is confirmed by the Harvard plates of this region, but the exact period has not yet been determined. C. P. B.

1490. *Poles of Double-star Orbits, Milky Way, and Nebula.* **K. Bohlin.** (Ark. för. Mat. Astron. och Fysik, Stockholm, 3. 19. pp. 1–8, 1907.)—The relative positions of the poles of various classes of the orbits of double stars, the Milky Way, the solar system, and the Andromeda nebula have been computed and plotted to indicate their probable distribution. The result is very suggestive in that all these positions lie in the same quadrant. C. P. B.

1491. *Comet Daniel,* 1907 (*d*). **E. Strömgren.** (Astronom. Nachr., No. 4185. p. 155, June 21, and No. 4187. p. 191, June 29, 1907. Nature, 76. p. 229, July 4, and p. 258, July 11, 1907. Abstract.)—Abridged ephemeris and chart of path of the new comet. Distinct stellar nucleus and faint fan-shaped tail. C. P. B.

LIGHT.

1492. *Photographic Reflector at Helwân, Egypt.* **J. H. Reynolds.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 447–450, May, 1907.)—Detailed description of the new photographic equatorial reflector recently installed at the Khedivial Observatory at Helwân, Cairo. The aperture of the mirror (made by Common) is 30 in., and the instrument is arranged on the Newtonian form with a small flat at 45° to the main axis. The photographic plate is provided with the well-known slipping-plate motion devised by Common. The chief work proposed for the instrument is nebular photography, especially of the region lying between the equator and 40° south declination. It is intended to add a good finder, so that cometary photography may also be done. C. P. B.

1493. *New Colour Meter.* **F. E. Ives.** (Frank. Inst., Journ. 164. pp. 47–56, July, 1907.)—The meter is a direct-vision instrument, based on the principle of Maxwell's colour box, but a low-dispersion grating is used in place of prisms. The field is divided by a diaphragm so as to be illuminated through a central slit for ordinary light on one side, and through three laterally displaced slits for the three-colour mixture on the other. A single lens placed in front of the four slits forms one telescopic image of external objects, divided by a vertical spider line in the eyepiece. The image in the right half of the field is produced by light from the three lateral slits, and all the light passes through two other lenses to the eye-slit. A grating placed between these two lenses, and covering one-half of the field, bends parallel to the axis blue-violet rays from the first lateral slit, green from the second, and red from the third. When the single slit is illuminated by light from a coloured surface, and the other slits by light from a standard white surface, the two halves of the field can be matched for hue and luminosity by micrometer screws which adjust the widths of the three lateral slits, and the colour of the object is then read off directly from the screw-heads, which are divided from 0 (closed) to 100 (fully open). The absolute aperture of the open slits has been determined by trial, so that the two halves of the field exactly match on a standard background. The instrument has a body 3 × 4 × 20 in. in size, and has all the operating screws a few inches from the eye. G. E. A.

1494. *Interference Films for Physical Experiments.* **F. H. Glew.** (Röntgen Soc., Journ. 3. pp. 132–133, June, 1907.)—These may be made by dissolving 8 grains of transparent celluloid in one fluid oz. of amyl acetate. From the varnish thus made 6 or 7 drops are quickly dropped on cold water. The interference colours develop in 2 or 3 min., and the film may then be lifted out on a wire frame. Coloured films over 1 ft. in diam. can thus be made. The films are strong and easily electrified, and are pervious to the α-rays. With the colours projected on a screen by reflected light, the film may be used to illustrate the acoustical properties of membranes. The films are, further, very durable, some having lasted, without deterioration, for 13 years. G. E. A.

1495. *Electron Theory of Dispersion in Gases.* **L. Natanson.** (Acad. Sci. Cracovie, Bull. 4. pp. 816–854, April, 1907.)—Investigates mathematically the optical dispersion in gases of different valencies on the basis of Drude's, Planck's, and Lorentz's theories, leaving aside the mutual action between electrons belonging to one molecule. Tabulates the values of the product $v\Delta$ of the number of "bonds" in the molecule and the number Δ of "dispersion electrons" in the molecule. This product varies from 14 to 28, and if the gases H_2, O_2, CO, CO_2, NH_3, CS_2, SO_2, and air alone are taken, the mean value is 16·8. In nitrogen and many of its compounds the product is nearer 28. The value of e/m deduced from these data is $1{\cdot}34 \times 10^7$, instead of $1{\cdot}865 \times 10^7$ as determined by Simon. The square of the natural frequency is calculated to be 46989×10^{28} in hydrogen and 56220×10^{28} in CO_2. E. E. F.

1496. *Dispersion in Artificial Double Refraction.* **L. N. G. Filon.** (Roy. Soc., Phil. Trans. Ser. A. 207. pp. 263–306, July 26, 1907. Roy. Soc., Proc. Ser. A. 79. pp. 200–202, May 14, 1907. Abstract.)—It is well known that glass and other transparent isotropic substances, when compressed unequally in different directions, behave like doubly-refracting substances and exhibit the colours of polarised light. Attention was first called to this by Fresnel and by Brewster in 1816. Further investigations were made by others, and particularly by G. Wertheim and by F. Pockels, both of whom considered how the effect varies with the nature of the light employed. If homogeneous parallel light is passed perpendicularly through a plate of thickness r which is subjected to principal stresses P, Q in its plane, these stresses being uniform throughout, then it is found that the light on traversing the plate is broken up into two rays polarised in the directions of principal stress. The relative retardation in cm. of these rays on emergence is given by $R = (\mu_1 - \mu_2)r$, where the μ's are the indices of refraction of the two rays. Now experiments have shown that $\mu_1 - \mu_2$ is very approximately proportional to the principal stress-difference in the wave-front, $P - Q$. Thus we may write—

$$R = C(P - Q)r,$$

where C is a coefficient called the "stress-optical coefficient" and depends on the nature of the material and on the wave-length of the light used. The experiments here described lead to the conclusion that the stress-optical coefficient may be represented by the approximate formula—

$$C = C_0/(1 - \lambda_0/\lambda) \text{ or } (C - C_0)(\lambda - \lambda_0) = C_0\lambda_0.$$

Thus the curve connecting C and λ is a rectangular hyperbola. When $\lambda = \lambda_0$, $C = \infty$, and as λ increases without limit, C decreases to its limiting value C_0, which in the glasses used varied from 2 to 3. E. H. B.

1497. *Effect of Temperature on Marine Refraction.* **W. Hall.** (Roy. Astronom. Soc., Monthly Notices, 66. pp. 372–374, April, 1906.)—Little reference has hitherto been made to the displacement of the visible horizon, which is capable of disturbing the sights made at sea, although it is not sufficient to give an actual mirage. An empirical formula is suggested embodying the results of some 300 observations, but it is noticed that one of the terms is discontinuous, changing sign suddenly when the temperature-difference changes sign. It seems possible that this may indicate some effect of *critical angle*, but this is as yet uncertain. A tentative table is given showing the corrections to be applied for various differences of sea and air temperatures and different heights of the eye. C. P. B.

1498. *Copper Mirrors.* **F. D. Chattaway.** (Chem. News, 96. p. 85, Aug. 23, 1907. Paper read before the British Assoc. at Leicester, 1907.)—Alludes to Faraday's method whereby a mirror-like deposit can be obtained by dissolving a little oxide of copper in olive oil and heating plates of glass in this liquid up to a temperature at which the oil decomposes. Such mirrors lack in brilliancy, being liable to staining or to discolouration in patches from the decomposition-products of the oil. During an investigation of the aromatic hydrazines, the author observed that when solutions of cupric oxide are reduced by these compounds, the metal is deposited upon clear glass in the form of a brilliant coherent film. Mirrors prepared by this process have the lustrous red of burnished copper, and are as perfect in reflecting surface and as uniform as silver mirrors obtained by the deposition of silver.

W. P. D.

1499. *Chemical Action of Light.* **P. Villard.** (Soc. Franç. Phys., Bull. No. 1. pp. 5–27, 1907. Journ de Physique, 6. pp. 369–379, May, and pp. 445–457, June, 1907.)—Print on albuminised or salted paper for a few seconds in daylight until the darkest parts of the print just begin to appear, then take out the paper and expose it to the sun under green or yellow glass which completely cuts off the blue and ultra-violet; in 10 hours the print has come up with all details and clear in the high lights. The presence of a soluble salt of silver is absolutely necessary for this continuation effect; bromide or chloride papers or plates will show it if they are exposed to the yellow or green light in a bath of nitrate of silver or of AgCl or AgBr dissolved in ammonia or hyposulphite of soda, though the darkening is never as great as with printing papers. With printing papers it can be increased by soaking the paper in a dilute solution of oxalic acid after the brief exposure under the negative. The action is not equivalent to a longer exposure under the negative, but to a physical development or intensification of the print. Dry plates show no such action. In any case the print must not have been fixed. A preliminary slight fogging by white light of printing paper exposed to a spectrum represents, as regards the violet part of the spectrum, merely an addition to the exposure; but it enormously increases the effect of the green and yellow rays, especially in the orange-yellow. This is due not to an increase of sensitiveness in the paper, but to the continuing action of the green and yellow rays having some deposit to work upon by intensification. If we print very faintly on printing-out paper under a negative and then continue the printing under green and yellow glass (cutting out all blue and violet), the contrasts in the print are greatly increased; the continuation action of the green and yellow rays is proportional (1) to the deposit already formed, and (2) to the amount of these rays locally traversing the negative; the effect produced therefore depends, as regards densities, on the *square* of the relative transparency of the different parts of the negative. In ordinary printing out we have, for the blackening, a term for the violet rays proportional to the time, and a term for the continuation effect, green and yellow rays, proportional to the square of the time; the curve is parabolic, and there is an acceleration in the rate of darkening after printing has once begun.

Where there is no continuation effect, as in dry plates, or no continuation rays, as in printing by violet light alone, the darkening produced is but slight. The destruction by one radiation of the chemical effect due to another is a very general occurrence. Platinocyanide of barium, browned by Röntgen rays, is regenerated on exposure to light, particularly in the green, the yellow, and the red. A dry plate acted upon by Röntgen rays so that it would blacken all over upon development will, if exposed in the camera, have the effect of the Röntgen rays undone by the light, so that it is possible, by exposure say 600 times what would have been requisite to produce a negative, to produce positives by this means, the dark shadows in which are due to the prior Röntgen-ray treatment and the high lights to the undoing of its effect by light. Long exposure to Röntgen rays induces a kind of solarisation, but the effect is always undone by light; and the longer the exposure to the Röntgen rays, the longer must be the exposure to light to effect regeneration. A minimum developable action of Röntgen rays on a dry plate is regenerated by the red and infra-red rays of the spectrum in the time which the violet rays would have taken to form a developable impression. A dry gelatino-chloride plate exposed to light—say one which has had a full camera exposure—can be completely regenerated by red and infra-red rays, say 4 hours' sunlight under suitable glass; and in spectrophotography the extreme red and infra-red may remain transparent if the stray light be balanced by these. A faint "sunning" of printing-out papers may be entirely undone by exposure under red and yellow glass, and then remain undevelopable. With AgCl there is no such effect. Under yellow and green glass, the continuation brings up a feeble print on printing paper; under yellow and red the maximum darkening may be made the same, but faint details are destroyed. The feebler the impression, the more rapid is the destructive effect of the red rays; but, on the contrary, the slower is the continuation effect of the green. The destructive rays are not the same for all substances. A. D.

1500. *Distortion of Photographic Films on Glass.* **S. Albrecht.** (Astrophys. Journ. 25. pp. 349–360, June, 1907.)—In various lines of astronomical research depending on photographic plates, discrepancies of considerable magnitude occasionally appear which may be due to distortion of the sensitive film. Previous investigators had found that distortion occurred which was often local and was usually small in amount. From a large number of measurements made on two sets of plates uniformly exposed but dried in different ways, it is found that the ordinary photographic treatment of quarter-plates does not induce distortion, but local distortions were found on areas confined in each case to a small fraction of a square millimetre. The distortions seem to be principally of two different kinds: one due to an actual movement of a minute portion of the film, and the other an apparent shift of the image due to local differences in the sensitiveness of the film. G. E. A.

1501. *Making and Selection of Filters for Orthochromatic Plates.* **J. McIntosh.** (Photographic Journ. 47. pp. 290–300; Discussion, pp. 300–304, July, 1907.)—Details the results of a large number of experiments with a spectroscopic camera fitted with a plain replica grating. The chief part of the paper is occupied with the consideration of photographs of a particular colour patch as taken with different plates and filters, and the method of making the filters is fully described. The paper is important to photographers, and the discussion is based on technical points. G. E. A.

1502. *Theory of the Photographic Process.* **C. E. K. Mees.** (Röntgen Soc., Journ. 3. pp. 117–120; Discussion, pp. 120–124, June, 1907.)—Summary of Hurter and Driffield's principles and methods. Speed of plates under Röntgen rays is proportional to their speed under light rays; the curve is, however, somewhat of the same form as would be found under light rays if the coating had no thickness; the velocity canstant and the development law are the same, and γ_∞ is practically the same for Röntgen rays as for light.
A. D.

1503. *Magnetic Birefringence of certain Organic Liquids.* **A. Cotton** and **H. Mouton.** (Comptes Rendus, 145. pp. 229–230, July 22, 1907.)—The authors find that the above property is not confined to colloidal liquids. It is present in nitrobenzine and is more or less marked in the members of the same aromatic series. On the other hand, none of the members of the fatty series studied are birefringent. Carbon disulphide exhibits feeble negative birefringence, whilst that of nitrobenzine is positive. [See Abstracts Nos. 2046 (1905), and 535 (1906).] G. E. A.

1504. *The Remarkable Case of Diffraction Spectra.* **Rayleigh.** (Phil. Mag. 14. pp. 60–65, July, 1907.)—R. W. Wood recently described the behaviour of a grating ruled upon speculum metal which exhibits certain discontinuities in the distribution of the brightness of its spectra [Abstract No. 420 (1903)]. These peculiarities are supposed to be caused by the passing off of a spectrum of higher order, *i.e.*, an abnormality might be expected at a particular wave-length of the first-order spectrum under observation, if, in the third-order, light of this wave-length were emerging tangentially to the grating surface. This explanation appears to be confirmed by calculations made with the aid of Wood's diagrams. The argument is illustrated by means of a peculiar case of interference of sound waves (Phil. Mag., 1897). An investigation applicable to light is now nearly completed. G. E. A.

1505. *Modification in Appearance and Position of an Absorption Band due to Presence of a Foreign Gas.* **R. W. Wood.** (Astrophys. Journ. 26. pp. 41–45, July, 1907.)—An investigation of the absorption band of mercury vapour at $\lambda = 2536$. Some mercury was in one experiment placed in a quartz bulb which was then thoroughly exhausted and sealed. A condenser discharge between cadmium electrodes was used as the source of light, and the absorption spectra of the mercury vapour at gradually increasing temperatures were photographed. As the density of the mercury vapour increases the absorption band widens out towards the red over a range of 400 Å.U., while its spread in the opposite direction is not more than 4 or 5 Å.U. If now the bulb is opened, allowed to fill with air and resealed, the band is found to broaden symmetrically. In a further experiment, when the quartz bulb was connected with a side tube in which the mercury could condense, the effect of the admixture of air was very striking. When the bulb was first heated, and the bulb still contained mercury and air, the band broadened symmetrically. As the temperature rose, and the air was driven gradually out of the bulb, the band contracted on the short wave-length side, notwithstanding the fact that the density of the mercury vapour was increasing all the time. Similar effects were observed with nitrogen, hydrogen, and helium
E. C. C. B.

1506. ***Influence of Atomic Weight upon the Maxima of Absorption and Reflection Bands.*** **W. W. Coblentz.** (Phys. Rev. 25. pp. 186–187, Aug., 1907. Abstract of paper read before the Amer. Physical Soc.)—One would expect to find the position of the maxima of the bands of selective absorption and of selective reflection, which are characteristic of certain groups of atoms, to be affected by the molecular weight of the compound. Previous experiments, directed to finding a shift of band with increase in the number of groups of atoms in the molecule, have failed. The author's recent investigations have shown the position of the band to depend upon the atomic weight of the element (metal) with which a group of atoms is combined to form a compound. A study of the reflection bands of the sulphates (H_2, Mg, Ca, Sr, Ba) SO_4, which have a series of reflection bands from 8·2 to 9·4 μ, and of the carbonates (Mg, Ca, Fe, Cu, Zn, Sr, Ba, Pb) CO_3, which have a complex double band at 6·5 to 7·2 μ, shows that the maximum of the band shifts towards the long wave-lengths with increase in the atomic weight of the metal, and confirms the author's previous work on transmission and reflection spectra. Thus, in the carbonates, the first reflection band has the following progressive positions: Mg, 6·5 μ; Ca, 6·58 μ; Fe, 6·62 μ; Zn, 6·64 μ; Sr, 6·72 μ (band unresolved); Ba, 6·8 μ; Pb, 6·94 μ. The second band shifts from 6·86 μ for Mg to 7·18 μ for Pb. In the sulphates the first reflection band shifts from 8·2 μ for Sr to 8·31 μ for Ba; and so on. Examination of the transmission bands of the sulphates furnishes similar evidence. A. E.

1507. *Influence of Pressure upon Absorption Spectra.* **A. Dufour.** (Comptes Rendus, 145. pp. 173–174, July 16, 1907.)—Some experiments upon the influence of pressure, up to 16 atmos., upon the absorption bands of nitrogen peroxide. Certain of the bands are found to be influenced, as, for example, $\lambda = 5856{\cdot}9$; on the other hand, certain bands are shifted towards the red by an amount proportional to the increase of pressure. All the bands which are sensitive to pressure-change are also sensitive, though very slightly, to the magnetic field. The shift of the lines is of the order of 0·015 Å.U. for each atmosphere increase of pressure. E. C. C. B.

1508. *Doppler-effect in Spectra of Hydrogen and Mercury.* **J. Stark.** (Astrophys. Journ. 26. pp. 63–65, July, 1907.)—In reply to previous remarks by Hull and work by the author [Abstract No. 1005 (1907)], Stark now presents reproductions of his photographs as evidence of his assertions, the matter being of considerable importance in reference to electronic structure. Three spectrograms are shown, obtained with a Rowland concave grating of 1 m. radius. In the case of hydrogen as well as mercury the canal rays moved towards the slit. It is seen that in both cases we obtain the lines at rest in their normal positions; simultaneously, on the side towards the ultra-violet the Doppler-effect is visible as a band of movable lines which were emitted with a different velocity by the particles of the canal rays. The ratio of the movable intensity to stationary intensity is large for hydrogen, and small for mercury lines, but variations are also shown among the lines of the same substance. The limiting value of the kathode drop for hydrogen is about 700 volts; for mercury it is different for various wave-lengths, *e.g.*, for λ2537, 8,000 volts; for λ4347, 7,000 volts; for λ4078, 15,000 volts. Further, the Doppler-effect can be observed for rapidly-moving canal rays in mercury vapour and helium lines, whether there is a considerable amount or only a small amount of hydrogen admixture with these gases. C. P. B.

1509. *Index of the Principal Lines of the Spark-spectra of the Elements.* **J. H. Pollok.** (Roy. Dublin Soc., Proc. 11. 16. pp. 184–216, July, 1907.)—This paper contains a list of the principal lines in the spark-spectra of the elements, together with their intensity and persistence for purposes of spectrographic analysis. By the persistence is meant the dilution at which the lines appear, and, as Hartley has shown, this has not necessarily any connection with the intensity. The table refers to the spark-spectra of solutions as obtained with gold electrodes, and the persistence is indicated by the Greek letters ϕ, χ, ψ, ω; ϕ meaning that the line is seen with a 1 per cent. solution, χ with a 0·1 per cent., ψ with a 0·01 per cent., and ω with a 0·001 per cent. solution. The table is given in order of wave-length and extends from $\lambda = 8950$ to $\lambda = 1862$. E. C. C. B.

1510. *Quantitative Spectra of Iron, Aluminium, Chromium, Silicon, Zinc, Manganese, Nickel, and Cobalt.* **J. H. Pollok** and **A. G. G. Leonard.** (Roy. Dublin Soc., Proc. 11. 17. pp. 217–228, July, 1907.)—The quantitative spark-spectra of the above elements undertaken with a view of determining the persistence of the lines [see preceding Abstract]. The nomenclature employed is the same, except that the lines only to be seen with the metal itself are indicated by the letter T, while those lines only to be seen with strong solutions are indicated by σ. E. C. C. B.

1511. *Studies on Fluorite.* IV. *Kathodo-Luminescence of Fluorite.* **H. W. Morse.** (Amer. Acad., Proc. 43. No. 1. pp. 3–16, June, 1907. Contribution from the Jefferson Phys. Lab., Harvard Univ.)—The fluorite crystals were mounted in a ground glass joint so that they could be turned round in the vacuum tube, and their different faces exposed to the kathode stream. Crystals from seven different localities were examined and their spectra observed under the influence of kathode rays. The spectra consist of lines and bands lying between $\lambda = 6112$ and $\lambda = 4145$, and differ to a certain extent according to the locality from which the crystals were obtained. Full tables and a plate of the spectra are given in the paper. E. C. C. B.

1512. *Phosphorescence of Manganiferous Calcium Compounds. Influence of the Constitution and Mass of the Molecules on the Wave-lengths of the Radiations emitted.* **L. Bruninghaus.** (Comptes Rendus, 144. pp. 1040–1042, May 13, 1907.)—The author examines spectrometrically the light emitted from a number of calcium compounds which contain manganese in the proportion of 1 Mn : 254 Ca, and which are subjected to the action of kathode rays. The spectra obtained are all limited in extent and, on comparing the different wave-lengths corresponding with the maximum intensities, it is found that the light emitted becomes more refrangible as the molecular weights of the calcium compounds increase, but that no simple relation exists between the various wave-lengths. The characteristic colour of the phosphorescence of a compound depends on (1) the chemical constitution of the diluent molecules (calcium salt), and (2) the mass of the diluent molecules. The centres emitting the phosphorescence—probably the electrons—are hence directly dependent on the structure and mass of the diluent molecules. [Compare Abstract No. 1155 (1907).] T. H. P.

1513. *Polarisation of Röntgen Rays and Secondary Rays.* **H. Haga.** (Ann. d. Physik, 23. 3. pp. 439–444, July 5, 1907. Phys. Inst. d. Univ., Groningen. Écl. Électr. 52. pp. 162–164, Aug. 3, 1907.)—After investigation of the behaviour of Röntgen radiation, Barkla concluded that it was partially polarised. In a later research he showed that the secondary rays emitted by a carbon plate are completely polarised. The author of this paper has confirmed the result of Barkla as to the secondary radiation by a photographic method. He obtained two distinct maxima and two minima of intensity, and concludes that the secondary rays are polarised. He used a carbon plate as polariser, and a carbon cone as analyser. Various other substances can serve as polarisers, such as copper, lead, and aluminium. According to his researches the primary Röntgen rays are not polarised. J. J. S.

1514. *Effect of Pressure on Radiation from Radium.* **A. Schuster.** (Nature, 76. p. 269, July 18, 1907.)—For an investigation on the effects of pressure on radio-active phenomena a special pump was constructed [designed by Petavel, Abstract No. 1448 (1907)], which allowed a pressure of about 2,000 atmos. to be kept up almost indefinitely without sensible leak. The results were negative. It is estimated that a change in the activity of ½ per cent. would have been noticed. A. S. Eve and F. D. Adams have subjected the products of radium to a high pressure for several days, but found no change in the radiation. The pressures were raised to the value of about 160 tons to the sq. in., and were, in some of the experiments, equal to the pressure at a depth of 50 miles below the earth's surface. The transformations take place in the usual manner at these pressures. The important conclusion follows: That radium generates heat by disintegration equally at the surface of the earth and at pressures which obtain at depths 40 to 50 miles beneath the surface. J. J. S.

1515. *Radio-activity of Radium.* **G. A. Schott.** (Phil. Mag. 14. pp. 210–212, July, 1907.)—A note pointing out that there are two classes of theories as to the cause of radio-activity: (1) Those which assume the positive charge of the atom to be at rest, while the negative charges are also at rest or are in motion; (2) those which assume both positive and negative charges to be in motion with large velocities; and that these two classes lead to essentially different conclusions as to the proportion in which the energy emitted by radium is distributed between α- and β-particles, and so can be subjected to the test of experiment. Theories of the first class ascribe the energy of α- and β-particles to potential energy stored in the atom, for the greater part, and according to them the heating effect of radium must be attributed to the β-particles. Theories of the second class, which assume that the greater portion of the kinetic energy of the α-particles exists as kinetic energy in the atom, ascribe to the α-particles the bulk of the energy emitted by radium. Further direct measurements on the distribution of energy between the α- and β-particles are desirable. J. J. S.

1516. *β-Rays from Radium E.* **H. W. Schmidt.** (Phys. Zeitschr. 8. pp. 361–373, June 1, 1907. Phys. Inst. d. Univ., Giessen, April 3, 1907. Écl. Électr. 52. pp. 17–19, July 6, and pp. 51–54, July 13, 1907.)—RaE is chosen as a source of β-rays on account of the homogeneity of the radiation. The absorption by various screens of aluminium and other substances is determined, and it is found that for thin layers of Al the absorption-coefficient is 40·0 cm.$^{-1}$, and that this increases with the thickness of the material and depends upon the conditions of the experiment. The absorption experiments also indicate the presence of γ-rays of intensity about 0·016 per cent. of that of the β-rays, and of absorption-coefficient 0·8 cm.$^{-1}$. The dispersion produced by the aluminium filter is then determined by allowing the radiation to pass through cylindrical holes in a lead sheet both before and after traversing the Al. The author lays stress upon the fact that the lateral effect is due to dispersion of the primary radiation and not, as is often stated, to a secondary radiation. In order to determine whether the rays, after passing through the Al, are of the same nature as those falling upon it, the deviation produced by a magnetic field is determined by observing what strength of field is required to cause them to traverse a circular channel cut in a block of lead. In this way the velocity of the β-rays is found to be 2·49 × 10^{10} cm./sec., and no change of velocity on traversing the Al screen could be observed. Hence it appears probable that absorption is produced by the arresting of a certain percentage of particles by a layer of any given thickness, the remaining particles continuing to travel with undiminished velocity. S. G. S.

1517. *Note on RaE₁ and RaE₂.* **S. Meyer** and **E. v. Schweidler.** (Phys. Zeitschr. 8. p. 457, July 15, 1907.)—The authors have previously shown that RaE is not a simple product but consists of two—RaE$_1$ and RaE$_2$ [see Abstract No. 71 (1907)]. H. W. Schmidt in his paper on β-rays [see preceding Abstract] has suggested that this conclusion is due to the presence of a small quantity of RaD. In the present paper the authors maintain their original contention. S. G. S.

1518. *The Decay Constant of Radium D.* **S. Meyer** and **E. v. Schweidler.** (Phys. Zeitschr. 8. pp. 457–461, July 15, 1907. Extract. Akad. Wiss. Wien, Sitz. Ber. 116. 2a. p. 701, 1907. Écl. Électr. 52. pp. 237–240, Aug. 17, 1907.)—An expression for the mean life of RaD is obtained in terms of measurements of the α-rays of RaC and RaF, and also of measurements of the β-rays of RaC and RaE$_2$. The former gives the more reliable result, as the α-rays can be completely absorbed by a thickness of a few cm. of air; also the β-radiation from RaC is harder than that from RaE, and further is not homogeneous, having therefore no definite absorption-coefficient. In the experiment a piece of platinum is placed in a closed vessel for 268·6 days with 0·5 gm. of radium barium bromide; on being taken out it is cut into three pieces. No. I. is examined for total radiation, and No. III. wrapped in tin-foil and examined for β-radiation; No. II. served for control experiments—its total radiation was the same as I. and its β-radiation the same as III. From No. I. the radio-activity for the first 2 hours is determined, and by extrapolation the activity for the RaC for time $t=0$ is obtained. From the remaining activity after 24 hours the radiation from RaF is obtained, the assumption being made throughout that the β-rays are a negligible part of the total radiation. This gives mean life as 17·2 years, and time for decay to half as 11·9 years. From No. III., using the β-radiation, the constants are respectively 51·5 years and 35·7 years. This discrepancy is explained by the complexity of the radiation from RaC, and the authors consider the smaller values obtained from measurements of the α-rays the more reliable. S. G. S.

1519. *Chemical Action of Radium Emanation. I. Action on Distilled Water.* **W. Ramsay.** (Chem. Soc., Journ. 91. pp. 931–942, May, 1907.)—The author first describes a qualitative confirmation of the observation made by Rutherford that the emanation from radium, in decaying, evolves a large amount of heat. When dissolved in water, radium bromide causes the evolution of a considerable quantity of gas, the mean volume obtained being 82·0 c.cm. per gm. of crystalline radium bromide ($RaBr_2, 2H_2O$) per 100 hours. After explosion, this gas leaves a residual excess of about 5·5 per cent. of hydrogen, reckoned on the total volume. Reasons are adduced to show that hydrogen is not one of the products of the degradation of radium, and other hypotheses to account for the excess of hydrogen are considered. If the gas is collected over mercury, the excess of hydrogen is greatly increased, owing to the fact that the emanation causes oxygen to attack mercury. The action of the emanation alone on water also decomposes it into a mixture of hydrogen and oxygen containing excess of the former, whilst, when mixed with detonating gas, the emanation causes recombination. Attempts were made to determine the rate at which water is decomposed by the emanation, but the measurement is complicated by several disturbing factors. T. H. P.

1520. *Radium Emanation.* **A. T. Cameron** and **W. Ramsay.** (Chem. Soc., Journ. 91. pp. 1266–1282, July, 1907.)—Investigations were made on the amount of radium emanation obtained from a known amount of radium bromide in a given time, its behaviour as regards pressure and temperature, and the changes in volume which it undergoes spontaneously. In all cases the emanation undergoes a rapid change of volume in a short period of time, and this change is followed by a slow change corresponding with its loss of electrical activity. In about one hour and a quarter, or one hour and a half, the volume decreases to one-half its original value. The decrease was shown not to be due to absorption or occlusion by the walls of the tube containing the gas. The hypothesis that the emanation decomposes into a solid which deposits on the walls of the tube, leaving a gas which occupies only half the original volume, is extremely improbable, and there remains the hypothesis which the authors regard as the true explanation of what occurs, viz., the monatomic gas Em_1 becomes diatomic Em_2 with consequent halving of volume. This hypothesis agrees with all the known facts. The change from Em_1 to Em_2 involves an exponential curve, and that has been realised. A rise of temperature should cause dissociation, and that has been observed. Rutherford's sequence would then become Ra—Em_1—Em_2—RaA—RaB—RaC, &c. On the assumption that one atom of radium produces one atom of emanation, and that both gases are monatomic, Ramsay and Soddy found from two experiments that the average life of the radium atom was respectively 1,050 and 1,150 years. From 1 gm. of radium there will be produced in 3·86 days 3·585 mm.^{3} of emanation. If Q is the equilibrium quantity of emanation (produced after infinite time), Q_t the quantity produced in time t, measured in days, and λ a constant representing the proportion of emanation changing per day, then $Q_t/Q = 1 - e^{-\lambda t}$, and $\lambda = 0·1796$. Using this formula, the amount of emanation formed in one day is found to be 1·162 mm.^{3}. Since 1 gm. of radium, on the assumption that it is a monatomic gas, occupies $(2 \times 11·2)/225 = 0·1$ litre $= 10^5$ mm.^{3}, the proportion of radium changing per day is $1·162 \times 10^{-5}$. The average life will be the reciprocal of this number, $10^5/1·162$ days or 236 years. This is totally at variance with the number obtained by Rutherford and others from theoretical considerations. J. J. S.

1521. *Chemical Nature of the Radium Emanation.* **L. M. Dennis** and **L. F. Hawley.** (Phys. Rev. 24. pp. 511–514, June, 1907.)—Rutherford concluded that the emanation from thorium and that from radium cannot be due to the excited activity of a member of the argon group or of any other constituent of the atmosphere, because when CO_2 is passed over thoria the amount of emanation is the same as when air is substituted for the CO_2. The authors considered that it was possible that air was not entirely excluded from the CO_2 used in Rutherford's experiment, and they repeated the tests, carrying them out in an atmosphere of hydrogen. The result was to confirm the statements of Rutherford that the emanation is not due to the excited activity of a constituent of atmospheric air. J. J. S.

1522. *Secondary Radium Radiation.* **A. S. Mackenzie.** (Phil. Mag. 14. pp. 176–187, July, 1907.)—Experiments were made to examine the secondary radiation from the back of a plate bombarded by the rays from radium. The radium used was placed at the apex of a conical opening in a massive block of lead so as to restrict to a definite bundle the beam of radium rays. It was found that the β-rays which ceased giving "reflected" rays after the thickness of lead traversed reached ¼ mm., gave "transmitted" rays up to the limiting thickness used, 15·6 mm., and the intensity even for this thickness was relatively great. The result was unexpected, and further experiments showed that β-rays which cannot pass through 1·8 mm. of lead will yet set up rays from the far side of a plate of lead 9·2 mm. thick when they strike the near side of it. Even the softest rays (those absorbed by ¼ mm. of lead) cause these transmitted rays in a 9·2-mm. plate. Investigation of the "transmitted" γ-ray leak showed that as the smallest thickness of lead-foil used, $\frac{1}{50}$ mm., is increased the leak increases instead of decreasing: it reaches a maximum for a thickness of about ¾ mm. of lead and thereafter decreases steadily, but remains large for a thickness of even 15·6 mm. The shape of the block of lead used to surround the radium and the position of the ionisation cell were so arranged that no secondary radiation from the sides of the opening in the lead, nor from absorbing plates nor from any portion of that end of the block, could enter the ionisation cell, but γ-rays were found to have entered the latter, and these were produced by γ-rays striking air. The process whereby secondary radiation is sent out from the back of a thick lead plate, the front of which is struck by easily absorbable primary β-rays, seems not to be a single action; the primary ray is not simply deflected nor simply absorbed, but the mechanical process resembles more a convective transference of energy such as is suggested by electrolytic convection. Perhaps the atoms which are bombarded absorb energy until internal instability is reached, and then a sort of explosion takes place with the expulsion of electrons and γ-rays; these in turn provide energy to be absorbed by the next layer, and so on through the plate. The method of measuring the absorption of a beam of radiation caused by a plate of given material, by noting the change of ionisation in a vessel when different thicknesses of that material are put in the path of the beam, gives not the absorbing power of the material, in the ordinary sense of the term, but the difference between what it absorbs and what it radiates; and as the latter quantity can be quite large the method is open to objections. J. J. S.

1523. *Radiation from Thorium A.* **F. v. Lerch.** (Phys. Zeitschr. 7. pp. 913–915, Dec. 15, 1906. II. Phys. Inst. d. Univ., Wien. Écl. Électr. 50. pp. 57–58, Jan. 12, 1907.)—By screening with thin layers of Al [$2{\cdot}1 \times 10^{-4}$ cm.] the radiation of ThA + ThB is more reduced than the radiation from ThB. By thicker layers of Al, on the contrary, the radiation from ThB is more weakened than that from ThA + ThB. On investigating the ionisation beyond the range of the α-rays and screening the ThA + ThB with an Al screen about $2{\cdot}8 \times 10^{-3}$ cm. thick, there appears a distinct falling-off in the radiation, whilst on screening ThB with the same screen there is caused rather a small increase of the ionisation. The ThA sends out a radiation which in part is less penetrating, but as to its largest part is more penetrating than the α-rays of ThB. J. J. S.

1524. *Radio-activity of the Gaseous Products from Mount Etna.* **C. Bellia.** (N. Cimento, 13. pp. 525–536, June, 1907.)—The author has examined the gases emitted by a fumarole on Etna, and by the salt-spring at Paternò, and from the dispersion produced by the gases when introduced into an Elster and Geitel electroscope, concludes that in each case the gas contains an emanation of the same nature as that of radium, the quantities contained by 1 litre of each being as much as is developed by 1 mgm. of pure radium bromide in $\frac{1}{125}$ and $\frac{1}{15}$ of a second respectively. Hence it is suggested that the radio-activity of volcanic products is the greater the less the depth from which it is projected. The gases have only been examined some time after collection, but so far no evidence of emanations of a thorium or actinium type has been detected. W. H. St.

REFERENCES.

1525. *Lamb's Grating Theory.* **C. Schaefer** and **M. Laugwitz.** (Ann. d. Physik, 23. 3. pp. 599–600, July 5, 1907. Phys. Inst. d. Univ., Breslau, May, 1907.)—In a previous work the authors compared their experimental results with the theory of J. J. Thomson as to the reflection of electric waves at gratings, and found a quantitative discrepancy. They now compare them with the theory of H. Lamb (which was brought to their notice by the reference of G. H. Thomson), and find a very good agreement between experiment and theory. [See also Abstracts Nos. 119 and 698 (1907).] E. H. B.

1526. *Arrangement for keeping a Train of Prisms in the Position of Minimum Deviation.* **M. Hamy.** (Comptes Rendus, 145. p. 53, July 1, 1907.)—A number of rods equal in number to the prisms are jointed together so that they can move in a horizontal plane. In the centre of each rod is mounted a revolving disc; these discs are toothed, and are so arranged that they engage into one another. These discs carry the prisms, and in this way the prisms are automatically kept in the position of minimum deviation. E. C. C. B.

1527. *Dark-room Filters.* **C. E. K. Mees** and **J. K. Baker.** (Photographic Journ. 47. pp. 267–272; Discussion, pp. 273–277, June, 1907.)—With panchromatic plates no dark-room filter is "safe"; the least tendency to injury is occasioned by a green filter which gives a maximum useful, visual effect with a minimum actinic effect. Particular combinations of stained gelatine are discussed. A. D.

1528. *Photography of the Spectra of Minerals: Galena and Argyrite.* **A. de Gramont.** (Comptes Rendus, 145. pp. 231–234, July 22, 1907.)—The author has photographed the spark spectra of these two minerals with a prism apparatus; the photographs are reproduced in the paper. E. C. C. B.

1529. *Wave-lengths and Structural Relation of Certain Bands in the Spectrum of Nitrogen.* **E. E. Lawton.** (Amer. Journ. Sci. 24. pp. 101–108, Aug., 1907.)—The bands in the positive spectrum of nitrogen with heads at $\lambda = 4059{\cdot}458$ and $\lambda = 3998{\cdot}419$ were measured on photographs taken with a large grating (20,000 lines, 21·5 ft. focus). The Deslandres formula $N = A\ (m + p/q)^2 + c$ has been applied with considerable success to the second of these bands. E. C. C. B.

1530. *Lumière "Autochrome" Dry Plates for Colour Photography.* (Scientific American, 97. pp. 42-43, July 20, 1907.) **R. Child Bayley.** (Photography, July 16, 23, 30, 1907.)—Descriptions of the new plate for production of coloured positive transparencies with camera exposures. The principle is that of three colours blended by proximity: an original mixture of starch grains, dyed in three respective colours, has those grains left transparent which correspond to the original colours of the object, and those masked over which correspond to the complementary colours. Gradations in the transparency and masking over result in a close rendering of all intermediate colours. A. D.

1531. *Tribolumoscope.* **F. H. Glew.** (Röntgen Soc., Journ. 3. p. 132, June, 1907.)—An instrument for observing the light given out by certain crystals and minerals when these are rubbed or scratched; also for spectroscopic observation or photographic recording. A. D.

1532. *The Zeeman-effect as evidenced by the Blue Lines of Zinc.* **P. Weiss** and **A. Cotton.** (Soc. Franç. Phys., Bull. 2. pp. 140-157, 1907. Journ. de Physique, 6. pp. 429-445, June, 1907.)—A fuller account of the work dealt with in Abstract No. 415 (1907) [in which, *for* $e/m = 3{\cdot}54 \times 10^7$, *read* $e/m = 3{\cdot}534 \times 10^7$].

1533. *Wave-lengths of Röntgen Rays.* II. **J. D. van der Waals, Jr.** (Ann. d. Physik, 23. 2. pp. 395-396, June 13, 1907.)—A reply to the criticisms of W. Wien, in which the present author further explains his position. [See also Abstracts Nos. 348 (1906), 852 and 1008 (1907).] E. H. B.

1534. *Production of Helium by Polonium.* **H. Greinacher** and **M. Kernbaum.** (Phys. Zeitschr. 8. pp. 339-344, May 15, 1907.)—An account of an unsuccessful attempt to observe the production of helium by polonium. From a preliminary calculation the authors were led to expect that it would be possible to detect the change spectroscopically. A discussion of the reasons of their failure is given. R. S. W.

1535. *Theory of the Radio-active Disintegration of Matter.* **P. Gruner.** (Archives des Sciences, 23. pp. 5-25, Jan.; 113-128, Feb., and pp. 329-355, April, 1907.)—The author gives a concise summary of the properties of the different radio-active radiations and tabulates the chief physical data in a form convenient for reference. L. H. W.

1536. *Yttrocrasite, a New Yttrium-Thorium-Uranium Titanate.* **W. E. Hidden** and **C. H. Warren.** (Amer. Journ. Sci. 22. pp. 515-519, Dec., 1906.)—A radio-active mineral containing 49·72 per cent. TiO_2, and 25·67 per cent. $(YtEr)_2 O_3$, 8·75 per cent. ThO_2, 1·98 per cent. UrO_2, &c. T. M. L.

1537. *Radio-activity of Mineral Springs and Sediments.* **C. Engler** and **H. Sieveking.** (Zeitschr. Anorg. Chem. 53. 1. pp. 1-25, March 12, 1907. Techn. Hochschule, Karlsruhe.)—A fuller account of the authors' investigations [Abstract No. 102, 1906)], which have been extended so as to include other sources, comprising some Italian. Criticisms of their apparatus [Abstract No. 2188 (1905)] are answered by an experimental investigation the results of which show that such criticism is unfounded. L. H. W.

1538. *Measurement of Radio-activity.* **C. E. S. Phillips.** (Röntgen Soc., Journ. 3. pp. 89-96; Discussion, pp. 96-99, April, 1907.)—It is suggested that the strength of radio-active substances should be measured by the γ-rays they emit. R. S. W.

1539. *Ionisation produced by the Leaves of Plants.* **G. Costanzo** and **C. Negro.** (Phys. Zeitschr. 8. pp. 491-494, Aug. 1, 1907. St. Ludwigs-Gymnasium, Bologna. From the Italian.)

HEAT.

1540. *Melting-points of Rhodium and Iridium, and the Use of the Nernst Glower in High-temperature Measurements.* **C. E. Mendenhall** and **L. R. Ingersoll.** (Phys. Rev. 25. pp. 1–15, July, 1907.)—The work of the authors depends on the determination of the various temperatures of the Nernst glower and is based on exterpolation, the isochromatic formula—

$$\log E_\lambda = K_1 + K_2/T,$$

being employed, where E_λ is the emission of the radiation of wave-length λ at the absolute temperature T and K_1, K_2 are constants. To determine K_1 and K_2 observations at two temperatures only are necessary, and the temperatures chosen are those of the melting-points of gold and platinum. The method of observation was to place on the top of the glower a very minute particle of the metal to be tested and then gradually increase the glower current until the melting-point is reached. Several readings of the spectrophotometer at this temperature are taken, the wave-length used being 0·606μ. In some cases, especially when gold and platinum were used, it was possible to maintain the globule of metal in a semi-molten condition for some time, and hence several readings could be taken. In other cases it was found better to determine the current corresponding to the melting temperature by several experiments, and then maintain a steady current of this value while the readings were being taken. The melting-point of gold was taken as 1,065° C., but as the temperature of the melting-point of platinum is still uncertain the values of the melting temperatures are calculated (1) on the supposition that this temperature is 1,745° C. (Waidner and Burgess, Nernst and v. Wartenberg), and (2) on the supposition that it is 1,789° C. (Holborn and Valentiner). The mean values obtained for the melting temperatures of various metals are given in the following table:—

	(1).	(2).
Silicon	1,484° C.	1,452° C.
Palladium..................	1,548	1,576
Rhodium	1,907	1,968
Iridium	2,292	2,388

At the normal brilliancy the mean temperature of the Nernst glowers was (1) 2,124° and (2) 2,204°. The melting-point of one glower was found to be (1) 2,393° and (2) 2,500°. Observations were only made in air and only on those metals which oxidise very little. As a rule oxidation can be readily detected by a microscope. It is stated that the melting-point of rhodium (1,907° or 1,968°) is such a sharp and easily determined point that it should prove useful as a reference point in high-temperature measurements. It was noticed that certain particles of the metal "walked" from one end of the glower to the other. Gold shows a marked increase of radiating power on melting as compared with the glower; Pd, Pt, Rh, and Ir show the same to a smaller extent, while silicon shows the reverse effect very markedly. In a forthcoming paper these phenomena will be described at length. A. R.

1541. *Specific Heat of Iron.* **P. Oberhoffer.** (Metallurgie, 4. pp. 427–443, June 22; 447–455, July 8, and pp. 486–497, July 22, 1907. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—Gives results obtained between 0° and 1,500° C. with a very nearly pure sample of iron ($C = 0·06$ and $Mn = 0·05$ per cent.), by means of an apparatus, described in detail, in which oxidation of the sample is avoided by working *in vacuo*. The curve connecting the average specific heat observed in cooling from $t°$ to 0°, with t, has a form resembling that obtained by Harker [Abstract No. 2070 (1905)], but beyond 1050° it is practically flat, which is interpreted as showing that the specific heat of γ-iron is practically independent of temperature. The rest of the curve is practically two straight lines, joined by bends. The specific heats of α- and β-irons are thus directly dependent on temperature. The shape of the curve connecting the β and α ranges is shown to support Osmond's original view of the formation of a continuous series of mixed crystals corresponding to Ar_3. F. R.

1542. *Explosive Mixtures of Ether Vapour and Air.* **J. Meunier.** (Comptes Rendus, 144. pp. 796–798, April 15, and pp. 1107–1108, May 21, 1907.)—Only mixtures of ether vapour and air containing between 0·075 and 0·200 gm. of ether per litre are inflammable. With methane and air the lower limit of inflammability is about 0·086 gm. of the hydrocarbon per litre, while the upper limit is nearly the same as with ether. In the second paper the author, using smaller vessels, obtains, for the lower limit of inflammability of ether in air, the values 0·058 and 0·059 gm. per litre, which agree closely with the value, 0·06 gm. per litre, given by le Chatelier and Boudouard (1898). The high result formerly obtained was probably due to imperfect mixing of the air and ether in the larger vessel employed. The mixture burns without noise when it contains 0·06 gm. of ether per litre, but higher proportions of ether cause explosion, which is violent for 0·1–0·175 gm. per litre, and most violent for 0·12–0·15 gm. per litre. Combustion ceases when the mixture contains 0·195 gm. of ether per litre. Mixtures of carbon disulphide and air yield similar results, the higher limit of inflammability being reached with 0·9 gm. of the disulphide per litre. T. H. P.

1543. *Application of the Method of Limiting Densities to Permanent Gases at 0°: Constant of Perfect Gases.* **P. A. Guye.** (Comptes Rendus, 144. pp. 976–978, May 6, and pp. 1360–1363, June 17, 1907.)—The molecular weight of a perfect gas is given by $M = RL/n$, where L is the weight of a litre of the gas under normal conditions and n the number of gm.-mols. of gas in R litres, R being generally taken as 22·412. The following are the best available values for L, and are more concordant among themselves than the numbers given by Berthelot [Abstract No. 724 (1907)]: O_2, 1·4290; H_2, 0·08987; N_2, 1·2507; CO, 1·2504; NO, 1·3402; CO_2, 1·9768; N_2O, 1·9777; HCl, 1·6398; NH_3, 0·7708; SO_2, 2·9266. According to the method of limiting densities, $n = 1/(1 - A'_0)$, where A'_0 represents the deviation of the gas from Boyle's law at 0° between 0 and 1 atmo. The value of R, given by $M/L(1 - A')$, should be constant, but is found to increase as the critical temperature of the gas rises; thus for hydrogen its value is 22·410, and for nitric oxide 22·418. This variation is regular and is represented, to within about ± 1/22400, by $R' = 22·410(1 + 10^{-8}T^2)$. It is concluded that Berthelot's correction formulæ for A' (*loc. cit.*) are inadequate, that the corrected value for A'_0 should be $(A'_0 - 10^{-8}T_c^2)$, and that the value of R should be taken as 22·410. In the second paper the author calculates, for the gases CO_2, N_2O, HCl, NH_3, and SO_2, the values of R from the equation $R = M/L(1 - A'_0)$, M being the molecular weight, and L the weight of a litre of the gas at 0° under 1 atmo. pressure (lat. 45° and sea-level). The values of R obtained are not constant, but increase as the critical temperature of the gas rises, the value for CO_2 being 22·411 and that for NH_3 22·436. The variation is almost regular and, except for nitrous oxide, is expressed by the formula—

$$R\,(\text{calc.}) = 22{\cdot}410 + 15 \times 10^{-8}(T_c - 273)^2,$$

which is accurate to 2 parts in 10,000. If R is taken as 22·410, the calculated molecular weights of the gases are, in all cases but one, less than those derived from the experimental atomic weights. T. H. P.

1544. *Diffusion of Gases as an Irreversible Process.* **S. H. Burbury.** (Phil. Mag. 14. pp. 122–126, July, 1907.)—The following statement from G. H. Bryan's work on thermodynamics presents difficulties: "When two gases at equal pressure and temperature mix by diffusion, the loss of available energy and consequent gain of entropy is the same as would occur if each component were to expand by rushing into vacuum till it occupied the same volume as the mixture." Bryan asserts that when two gases mix by diffusion the process is an irreversible one, and the author understands him to imply that every irreversible process is attended by a loss of available energy. Both these theorems are disputed, and the following suggestions are made: The motion is only cyclic when the system is theoretically isolated; but the condition of complete isolation cannot be realised in practice. The vibrations coming from the surrounding medium, for instance, must always affect the gas in a closed vessel. This sufficiently explains why the cyclic motion of two diffusing gases can never be experimentally demonstrated. A. R.

1545. *Electrical Origin of Radiation from Hot Bodies.* **J. J. Thomson.** (Phil. Mag. 14. pp. 217–231, Aug., 1907.)—The idea on which this investigation is based is that the radiation from hot bodies is analogous to Röntgen radiation, *i.e.*, consists of a series of electromagnetic pulses produced by the stopping or starting of charged corpuscles in the hot body. This was suggested by the author in 1900, and the subject acquired importance on the derivation in 1902 by Lorentz of an expression for the energy in radiation of exceedingly long wave-length. The present author proceeds here to remove this restriction, and obtains expressions which reduce to Lorentz's form for long waves. It is thus found that the amount of energy transformed per c.cm. of a metal into radiant energy per sec. is surprisingly large; nearly the whole of this is absorbed by the metal and passes into a form other than that of radiant energy. At the temperature of 27° C. or 300° absolute the radiant energy produced per c.cm. of silver per sec. is $1{\cdot}5 \times 10^6$ cals., if the dielectric constant is written unity. Thus the radiant energy produced in a single c.cm. of silver represents about 8,000 h.p. Hence, though silver does not distribute its energy well, it produces per c.cm. as much as a good-sized electric lighting station. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1546. *Bases of the Electron Theory.* **G. A. Schott.** (Phys. Zeitschr. 8. pp. 433–438, July 1, 1907. Physikal. Inst., Bonn, May 31, 1907.)—Reviews the various hypotheses as to the ether and electrons, and arrives at the following position: Let the three necessary assumptions be made: A. The Maxwell-Hertz equations hold for the free ether. B. There are mobile electrons. C. The ether is conceived as a continuous medium whose properties are mechanically explicable, and which acts mechanically on the electrons. No special assumptions are made as to the possible structure of the ether and the electrons and their relation. From the above assumptions the author derives the following enunciations: A. The Lorentz theory is incompatible with the third assumption. B. One may extend it in two ways: *a.* If we assume that the electric force has a translatory and the magnetic force a rotatory character, we must also assume that the presence of an electric charge changes the properties of the ether, but in a manner difficult to explain mechanically. *b.* If, on the contrary, we attribute to the electric and magnetic forces the opposite character, we are forced to suppose that the ether takes part in the motion of the electrons, at any rate, in their immediate vicinity. [See also Abstract No. 1749 (1906).] E. H. B.

DISCHARGE AND OSCILLATIONS.

1547. *Mechanical Temperature Effects in Rarefied Gases.* **J. T. Bottomley** and **F. A. King.** (Roy. Soc., Proc. Ser. A. 79. pp. 285–295, June 8, 1907.)—Working with a gold-leaf electroscope in a vacuum it is found that a flame, or other hot body, or even the hand placed near the instrument, causes a repulsion of the leaves. If the flame is suddenly presented and withdrawn several times in succession the leaves obtain a large permanent repulsion for each other and stand permanently apart. A Nernst lamp at a distance of 6 m. produces similar effects. All these results are obtained equally well if the electroscope is thoroughly well screened electrically. Screens of various materials are interposed between electroscope and lamp. Coloured glasses diminish the deflection, but the effective radiations pass through coloured and white paper, through ice or alum solution. The radiations from a candle or a match are equally effective with a Nernst lamp in these cases, but the flame of a spirit lamp is altogether ineffective. Metal screens greatly reduce the effects. It is necessary, for these results to be obtained, to allow the light to fall directly on the leaves. R. S. W.

1548. *Dielectric Cohesion of Helium.* **E. Bouty.** (Comptes Rendus, 145. pp. 225–226, July 22, 1907.)—Monatomic vapours (Hg, argon) have a dielectric cohesion very small in relation to their atomic mass (Hg 354, air 419, argon 39, hydrogen 205). Helium purified by cooling and cocoanut charcoal gave a dielectric cohesion of 18·3. The presence of $\frac{1}{10000}$ its volume of a polyatomic gas raises the dielectric cohesion of helium distinctly. A. D.

1549. *The Law of Paschen.* **H. Wagner.** (Journ. de Physique, 6. pp. 615–619, Aug., 1907.)—This law states: On applying a p.d. between two electrodes, the product of the gas pressure into the maximum distance for discharge of the electrodes is constant. The author finds that the law is applicable for discharges in a uniform field across a gas between two parallel plates if the distance is at least several cm., but that the law does not apply in the case of small distances (down to 0·1 cm.) for pressures greater than the critical pressure. This is on account of the rapid variation of the dielectric cohesion for these distances. The variation in voltage is from 1,500 volts to 850 volts. P. E. S.

1550. *Vacuum Discharges with Strong Currents.* **H. Geiger.** (Ann. d. Physik, 22. 5. pp. 973–1007, May 2, 1907. Inaug.-Dissertation, Erlangen. Écl. Électr. 51. pp. 808–810, June 1, and pp. 842–844, June 8, 1907.)—By using platinum electrodes coated with an oxide of an alkaline earth it is possible to produce a current of several amps. in a vacuum tube, since the kathode fall of potential is practically obliterated. The author worked such a tube with a 220-volt supply, and found that the positive stratification was very pronounced, and not much affected by changes in the current strength. The radiation of positive light in wide tubes and at high vacua increases with the current, both as a whole and for each wave-length. The optical efficiency, or ratio of visible to total radiation, is in nitrogen 18 times as high as in the case of an amyl acetate lamp. The temperature of the positive column exceeds 1,000° even with feeble currents. It is approximately proportional to the product of current and p.d. The luminous strata are about 50° hotter than the dark strata, but the axial regions are much hotter than those near the wall of the tube. The potential gradient decreases with increasing current, and tends to a minimum value, which is arrived at the sooner, the higher the vacuum. E. E. F.

1551. *Duration of Kathodic Discharge in Vacuum Tubes.* **P. Doglio.** (Accad. Lincei, Atti, 16. pp. 868–874, May 19, 1907.)—The duration of each kathode discharge is from 0·0002 to 0·0008 sec. Within the limits of frequency of interruption under which a regular series of discharges is possible, the duration of each discharge does not depend upon the frequency; but if various capacities are put in shunt to the interrupter of the primary circuit, the duration of each discharge varies with the capacity according to a law approximately linear. This duration is therefore not a characteristic of a given tube, but depends upon the conditions of the external circuit. A. D.

1552. *Voltage and Pressure in Kathode Rays.* **R. v. Hirsch.** (Phys. Zeitschr. 8. pp. 461–463, July 15, 1907.)—The range of voltage is from 1,600 to 14,000 volts applied from a large influence machine; the pressures given range from 8/1,000 mm. to 104/1,000 mm. of mercury. The object is to test the validity of the expression, $p^2V =$ constant. The result found is that the value of p^2V depends (*a*) on the dimensions of the tube, (*b*) on the electrode metal, and (*c*) on the gas present; it also increases about 1·5 per cent. for 1° rise in temperature between 10° and 25°. For a mixture of gases p^2V is not constant. P. E. S.

1553. *Rays of Positive Electricity.* **W. Wien.** (Phil. Mag. 14. pp. 212–218, July, 1907.)—Referring to J. J. Thomson's paper on rays of positive electricity [Abstract No. 1069 (1907)], the author refers (1) to the observation of the existence of negative ions, deflected in the opposite sense to the positive in a magnetic field and with a small value of e/m, recorded by himself a few years ago, also to the electric charge of the positive rays and the fact that the negative ions are only a small part of the positive. (2) The possibility that the variable deflection of the canal rays in a magnetic field is due to the fact that the ions lose or receive their charge at different points of their path was also discussed by the writer in the paper to which he refers [Abstract No. 1728 (1904)], as well as the other hypothesis, viz., the possibility that there are ions of large mass; which assumption is correct seems not yet decided. (3) With regard to the hypothesis of Thomson, that the atoms of every gas split off hydrogen atoms, the writer considers that the value $e/m = 10^4$ when found in other gases is due to small residues of hydrogen. That the charged atoms of different gases do exist in the canal rays is also shown by the discovery by Stark of the Doppler-effect of the spectral lines.

J. J. S.

1554. *Mechanical Effects of Canal Rays.* **A. A. Campbell Swinton.** (Roy. Soc., Proc. Ser. A. 79. pp. 391–395, July 10, 1907.)—Goldstein's canal rays (Kanalstrahlen), which at suitable pressures visibly stream through the apertures in a perforated kathode, backwards away from the anode, share with kathode rays the property of producing a sufficient mechanical pressure to cause small and light mica mill-wheels to rotate. The best results are obtained with medium vacua, when the canal rays are highly luminous. The two sides of the mica vanes were found to differ in temperature by 200°, and the effect is probably due to this. The maximum difference of temperature took place at pressures which gave a maximum luminosity to the canal rays and a maximum velocity to the mill-wheel. The canal rays are supposed to be streams of positively electrified particles which, travelling towards the kathode, pass through the apertures in the latter, and emerge on the other side. These mill-wheels would appear to demonstrate the motion of these particles, both when they are approaching the kathode and after they have passed through the latter. Canal rays make lithium chloride fluoresce red; kathode rays make it fluoresce blue. The force exerted by kathode rays is greater than that exerted by canal rays; but if the mill-wheel be made of aluminium there are opposite results, further to be studied, which point towards the influence of conductivity for heat tending to equalise the temperatures of the two sides of the metal vane, as contrasted with the mica vane.

A. D.

1555. *Electric Arcs between Various Materials.* **W. L. Upson.** (Phil. Mag. 14. pp. 126–144, July, 1907. Paper read before the Physical Soc., June 14, 1907.)—The arcs were taken between a great number of materials, including carbon, iron, copper, aluminium in all possible combinations. The upper electrode was arranged so that it might be cooled by a water circulation when required. The arcs were in air, hydrogen, and coal-gas, for a considerable range of voltage and current. It was found that in coal-gas a deposit of carbon was immediately formed on any electrode, so that it was impossible to distinguish between different electrodes in this medium. The arc was found to take the form of a spark discharge with various metals in hydrogen, in which case the maximum length of 0·05 in. was reached for all such arcs, provided both terminals were not of the same metal. This was with 110 volts supply and 15 amps. If one electrode is carbon there is always a continuous arc. Characteristic curves were obtained for all the arcs by Mrs. Ayrton's method, and the voltage equations determined. Alternate-current arcs and interrupted arcs were also studied; in the latter case the time that various arcs could be interrupted without losing the power of restarting themselves was measured. J. E.-M.

1556. *The Alternate-current Arc.* **L. Puccianti.** (N. Cimento, 13. pp. 269–285, April, 1907. Phys. Zeitschr. 8. pp. 463–471, July 15, 1907. Translation. Écl. Électr. 52. pp. 298–301, Aug. 31, 1907.)—The arc was examined electrically by means of a Joubert disc, and optically by means of a slitless spectrograph based upon the instrument used for observing solar prominences. The latter instrument proved that the arc is not homogeneous spectroscopically, but consists of a number of superimposed arcs belonging to the various spectrum lines. Observed in the slitless spectrograph, the D-line gives an oval image of the arc, which is more pronounced at the negative end. As the arc passes through successive phases, the width of the D-line image changes but slightly. Shortly after the reversal phase it becomes somewhat narrower, and attains a minimum at $\frac{1}{12}$th period after reversal. A very different behaviour is shown by the lines of the first secondary series, of which the given line $\lambda = 568\,\mu\mu$ is the most prominent. At the highest phase this line gives an image closely resembling that of the D-line; it then becomes narrower and feebler, until at the "extinction phase" it disappears almost completely, afterwards reappearing narrow and intense, something like a spark. By measuring the width of the kathode base of the images, and thence calculating the sectional area of the conducting gas, values are obtained which are proportional to the current strength, with a slight increase during the decreasing phase. The author makes the important deduction that the lines of the first secondary series represent the real conducting medium of the arc. The ions producing this light have a constant conductivity independent of the phase. The D-lines, on the other hand, represent the "inert" portion of the discharge, which does not convey the electric current, but is produced by it. The various line images are sharply outlined. The interior is, in fact, less luminous than the edges, so that the whole arc appears to be hollow. This, however, is so unlikely that the author rather assumes that the central discharge is too hot to be visible, much as Lockyer's hottest stars are very poor in lines. As regards the sudden reappearance of the conducting spectrum, the author believes that during the extinction phase the arc is what Stark would call a "dependent conductor," becoming independent only when the potential gradient rises again to a certain value. E. E. F.

1557. *Potential Difference of the Direct-current Arc between Metallic Electrodes.* **C. E. Guye** and **L. Zébrikoff.** (Comptes Rendus, 145. pp. 169–170, July 15, 1907.)—The authors used the metals Au, Pt, Ag, Pd, Cu, Co, Ni, and Fe as electrodes. The ends of the electrodes were cylinders with flat ends slightly rounded at the edges, and their diam. was 16 mm. Before and after working their ends were polished on a lathe. The lengths of the arcs varied between 0 and 4 mm., but were rarely over 2 mm. The currents were varied from 2 to 18 amps. In order to get stable arcs a large resistance was put in series, the dynamo giving 90 volts. The upper electrode was always the kathode. Under these conditions the curves showing the relation between the current and the power expended in the arc were very approximately converging lines, thus proving that Mrs. Ayrton's law holds also for metallic electrodes. The following equations give the relation between the p.d. e, the current i, and the length of the arc l:—

$$\text{Gold, } e = 20{\cdot}82 + 4{\cdot}62l + (12{\cdot}17 + 20{\cdot}97l)/i.$$
$$\text{Platinum, } e = 24{\cdot}29 + 4{\cdot}80l + 20{\cdot}33l/i.$$
$$\text{Silver, } e = 14{\cdot}19 + 3{\cdot}64l + (11{\cdot}36 + 19{\cdot}01l)/i.$$
$$\text{Palladium, } e = 21{\cdot}64 + 3{\cdot}70l + 21{\cdot}78l/i.$$
$$\text{Copper, } e = 21{\cdot}38 + 3{\cdot}08l + (10{\cdot}69 + 15{\cdot}24l)/i.$$
$$\text{Cobalt, } e = 20{\cdot}71 + 2{\cdot}05l + (2{\cdot}07 + 10{\cdot}12l)/i.$$
$$\text{Nickel, } e = 17{\cdot}14 + 3{\cdot}89l + 17{\cdot}48l/i.$$
$$\text{Iron, } e = 15{\cdot}73 + 2{\cdot}52l + (9{\cdot}44 + 15{\cdot}02l)/i.$$

Mrs. Ayrton's formula for carbon is—

$$\text{Carbon, } e = 38{\cdot}88 + 2{\cdot}074l + (11{\cdot}66 + 10{\cdot}54l)/i.$$

For short "stable" arcs the above formulæ are accurate. With Fe, Ni, and Co difficulty was experienced, as woolly filaments formed and sometimes short-circuited the arc. A. R.

1558. *The Electric Arc with Small Currents.* **H. W. Malcolm** and **H. T. Simon.** (Phys. Zeitschr. 8. pp. 471–481, July 15, 1907. Inst. f. angew. Elektrizität, Göttingen, June, 1907.)—The range of current used is from 0·05 amp. to 2·6 amps. The relation of current to voltage necessary for discharge is investigated for electrodes of carbon, iron, copper, zinc, silver, lead, nickel, and for the gases, air, nitrogen, hydrogen, steam. The metal electrodes are in some cases cooled by a water stream round them, and the distance between the electrode is varied. The results are several. The relation given by Mrs. Ayrton, $ei = a + bi$, holds for small currents, for carbon poles in air, and other gases, and the constants a and b are given in some cases. Also the ei/i curves for metals are not normal, but concave to the i-axis. Curves are given for the various cases named. [See also Abstracts Nos. 146 (1906), 1465 (1905), 2293 (1904), and 1286 (1900).] P. E. S.

1559. *Oscillographic Study of Low-frequency Oscillating Arcs.* **J. T. Morris.** (Elect. Engineering, 2. pp. 219–223; Discussion, p. 223, Aug. 8, 1907. Electrician, 59. pp. 707–710, Aug. 16, 1907. Paper read before the British Assoc. at Leicester.)—The author investigates the effects on direct- and alternating-current arcs of changing the medium in which they burn, and also the effect produced on the arc by the application of a transverse magnetic field. Oscillograms are given of the current and voltage waves of an alternating 440-volt arc in air, and also in coal-gas when the frequency is 60. The want of symmetry of the voltage wave when working in coal-gas is very marked, the pressure rising to 870 volts before the resistance of the arc breaks down. From these characteristics are plotted "dynamic characteristics" (first employed by Blondel in 1891, and recently extensively used by Simon). These show that the approximate resistance in air when the arc is starting is about 500 ohms, while in coal-gas it is 6,000 ohms. The diagrams show that the "hysteresis loops" (Simon) for coal-gas are much greater than for air, and hence the coal-gas is a much more efficient medium for producing oscillations. The experiments were repeated with the arcs placed in a magnetic field of 3,300 c.g.s. units.

The effects produced by the magnetic field on the oscillograms are slight. The average max. voltage when the current is stopping is greater with the magnetic field. In coal-gas, for instance, it was 88 volts when the magnetic field was applied and 74 without it, and in air 77 volts with the field as compared with 61 without. This is probably due to the fact that the arc (being bent into the shape of a bow) is longer when the current is stopping than when it is starting. When a direct arc is suddenly extinguished by the application of a transverse field it goes out with a shriek. This suggested to the author that the current through the arc was pulsating, and his oscillograms show that this is the case. He finds that the stronger the magnetic field the higher the frequency of the pulsations. Oscillograms of the current are shown for field strengths of 80, 120, 300, and 800 respectively, the frequencies produced being 57, 210, 1,800, and 4,300. An examination of the arc showed that on the positive pole the arc formed a number of separate glowing spots in a vertical plane, while the negative electrode showed a short bright line. These oscillations may be explained by the fact that the arc exhibits a tendency to shorten, and that a curved arc requires a greater voltage than a straight arc. This oscillatory action may possibly be dangerous, when the field has a certain strength, in those forms of circuit-breakers where the magnetic field blows out the arc. A. R.

1560. *Measurements of Spark-resistance in Oscillatory Circuits.* **W. Eickhoff.** (Phys. Zeitschr. 8. pp. 494–496, Aug. 1, 1907. Physikal. Inst. d. techn. Hochschule, Braunschweig, March 26, 1907. Écl. Électr. 52. pp. 390–392, Sept. 14, 1907.)—The author points out that the two generally used methods of determining the spark resistance, viz., the resonance method of Bjerknes (as used by Drude and Rempp), and the substitution method of Simons (as also used by Slaby and by Fleming), give results which quantitatively and qualitatively are not in agreement, the curves plotted between length and resistance of the spark being wholly different. He has carried out a series of measurements with both methods on the same oscillatory circuit, and obtains curves which agree fairly with Rempp's and qualitatively with Slaby's results; hence it is not a question of miscalculation. It is well known that in the first method there is but a single spark-gap, and variation of this length alters the potential- and current-amplitude. In the second case the amplitude is determined by the length of the auxiliary, or second, spark-gap; it is therefore independent of the actual spark-length which it is desired to measure. What one measures here is thus the dependence of spark-resistance on spark-length at practically *constant current-amplitude,* as was pointed out by M. Wien [Abstract No. 847B (1907)]. The results obtained by the second method are therefore wholly unsuitable for direct comparison with those obtained with a single spark-gap. Curves are given which show that the spark-resistance by the second method depends also on the *length* of the *auxiliary* spark-gap. Again, with the resonance method the resistance of the circuit can be kept very small (Rempp), but in the substitution method the auxiliary gap is always equal to, or longer than, the gap which is being measured, and hence there is always a resistance in the circuit which is not less than the actual spark-resistance to be measured. The resonance method furnishes at once the most important value—the effective value of the total resistance (as well as the *total* damping). In cases where it is desired to separate the energy lost in the spark from the other losses, Simons' method, however, is very suitable. Both methods are inapplicable in the case of subdivided, or multiple, spark-gaps. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1561. *Effect of Alternate Currents and Heat Cycles on Selenium Cells.* **A. Pochettino and G. C. Trabacchi.** (N. Cimento, 13. pp. 286–314, April, 1907.)—Photo-electric selenium cells may be classified in two divisions: Those of the first kind have a high resistance at ordinary temperatures, and show a "positive" photo-electric effect, in the shape of a diminution of resistance on illumination. Those of the second kind have a rather low resistance and a negative photo-electric effect. Both types were subjected to a cycle of heating and cooling. It was found that in cells of the first type there is a well-marked hysteresis. The resistance falls on heating and rises on cooling, but only attains the original value after 12 or 24 hours. The second species shows no such hysteresis. When the cycle is repeated many times the resistance of the first species attains a certain minimum, and the cell becomes much less sensitive to light. The thermal coefficient of resistance is sensibly the same in both species, but in the first species it is greatest in the dark. An application of an alternating current for 10 sec. between the temperatures of 90° and 100° is accompanied by an almost instantaneous increase of resistance in cells of the first species. In cells of the second species this instantaneous increase is followed by a slow increase lasting 4 or 5 min., and then by a considerable diminution down to the resistances obtaining at low temperatures. Both kinds of cells may have their resistance increased by an alternating current at ordinary temperatures [see Abstract No. 1612 (1906)]. If they are then heated the resistance falls, but on cooling the resistance does not return to its value before heating, but remains lower, so that the effect of the alternating current may be destroyed rapidly by heating instead of slowly by time. Neither in the heat cycle nor in the alternate-current treatment is there any sensible absorption or evolution of heat in the selenium. Selenium cells of high resistance do not follow Ohm's law. With increasing voltage the resistance and the photo-electric effect diminish. A direct current, and especially the discharge of an electrostatic machine, have also the power of increasing the resistance of selenium, but not so much as the alternating current. E. E. F.

1562. *Behaviour of Selenium towards Light and Temperature.* IV. and V. **R. Marc.** (Zeitschr. Anorg. Chem. 53. 3. pp. 298–318, April 17, 1907. Mineralog.-Geolog. Inst. d. Univ., Jena, Jan. 31, 1907.)—The author has already shown by two independent methods that grey crystalline selenium exists in two distinct polymorphous forms, A and B; A is a non-conductor, B a good conductor of electricity. The transition from the A form at 140° to the B form on heating to 200° has now been observed microscopically. It has also been found that there is a difference in the solubilities of the two modifications; B is probably rather less soluble in carbon bisulphide than A. The equilibrium mixture at the ordinary temperature is sensitive to light, which displaces the equilibrium from A to B just as does rise of temperature; the action of the light is, however, a photo-chemical and not a calorific effect. The author makes the following recommendations for those interested in the construction of sensitive selenium cells: (1) An addition of 0·1 to 0·5 per cent. of silver or other efficient catalytic agent; (2) the complete transformation (preferably in an oxygen-free atmosphere) at 200°; this can be best traced by the use of a galvanometer; (3) the establishment of a complete equilibrium at the ordinary temperature; (4) the employment of as thin a film of selenium as possible; (5) the arrangement of the electrodes should be such that the rays of light fall upon the places of greatest current density; (6) access of moisture is to be prevented.

D. H. J.

1563. *Electrical Resistance of Metallic Mixed Crystals.* **W. Guertler.** (Zeitschr. Elektrochem. 13. pp. 441–445; Discussion, pp. 445–446, July 19, 1907. Paper read before the 14th Hauptversamml. d. Deutsch. Bunsen-Gesell., Hamburg, May 10, 1907.)—The difference between the observed resistance, W, and that calculated as a mean of those of the components, W_1, is independent of the temperature and proportional to the concentration of the components. It is pointed out that there is a difficulty in the adoption of Schenck's theory of the increase in internal friction by adding one metal to another [see Abstract No. 1050 (1907)], as it would require the ratio of W and W_1 to be constant.

F. R.

1564. *Variation of Manganin Resistances with Humidity.* **W. Jaeger** and **St. Lindeck.** (Electrician, 59. pp. 626–627, Aug. 2, 1907.)—The authors conclude that the work of Rosa and Babcock [see Abstract No. 1392 (1907)] confirms the statement made by the Reichsanstalt for more than 10 years, that manganin is a material with a particularly constant resistance. They think it important also to call attention to the fact that the source of error which has been found in the climate of Washington need cause no anxiety to the owners of such resistances, for (1) the phenomenon makes its appearance to the extent noticed only in a climate as unfavourable as that of a Washington summer; (2) it affects only high resistances; (3) the variations noticed are unimportant for most practical measurements. The phenomenon has not yet been observed at the Reichsanstalt; but whereas the humidity in the Washington laboratory often rises to over 70 per cent., a humidity as great as 65 to 70 per cent. was only observed during a few summer days at Charlottenburg. The following table gives the results of measurements on 10 coils:—

VALUES IN INTERNATIONAL OHMS AT 18° C.

Designation of Coil.	Measured Values.		Difference June–April in 1/1000 per Cent.
	End of April, 1907.	End of June, 1907.	
10 A	10·0001$_{9}$	10·0001$_{7}$	− 0·2
10 B	10·0001$_{1}$	10·0000$_{7}$	− 0·4
100 A	99·992$_{0}$	99·991$_{7}$	− 0·3
100 B	99·990$_{1}$	99·989$_{7}$	− 0·4
1,000 A	1,000·05$_{2}$	1,000·06$_{8}$	+ 1·6
1,000 B	1,000·03$_{1}$	1,000·04$_{3}$	+ 1·2
1,000 C	1,000·07$_{3}$	1,000·09$_{2}$	+ 1·9
10,000 A	10,005·1$_{7}$	10,005·2$_{3}$	+ 0·6
10,000 B	10,005·1$_{3}$	10,005·1$_{2}$	− 0·1
10,000 C	10,002·2$_{4}$	10,002·2$_{4}$	± 0·0

For two reasons the above resistances ought to have shown the phenomenon at least as strongly as those of Rosa and Babcock. (*a*) Since April, 1907, the Reichsanstalt coils were exposed to the air, while those at Washington were immersed in oil during the whole time of observation. (*b*) The humidity in the laboratories in Washington during the summer was reduced for 6 to 8 hours every day; this was not done at Charlottenburg. The conclusion drawn from the above observations, and from a mass of other observations available at the Reichsanstalt, is that the variations of resistance due to shellac, if existing at all in the climate of Charlottenburg, must remain very small. F. E. S.

1565. *Dielectric Constant of Air at High Pressure.* **K. Tangl.** (Ann. d. Physik, 23. 3. pp. 559–574, July 5, 1907. From paper read before the ungar. Akad. d. Wissensch., April 22, 1907.)—Nernst's bridge method was modified to measure the change of capacity which took place in a condenser when filled with compressed air. The dielectric constant (D) was measured up to 100 atmos., and the following results were found:—

Pressure...	20	40	60	80	100
D............	1·0108	1·0218	1·0330	1·0439	1·0548

These numbers are for 19° C. The Clausius-Mossotti expression—

$$(D-1)/\sigma(D+2)$$

shows a slight decrease with increasing pressure, σ being the density of air, referred to that at 0° taken as unity. The quotient $(D-1)/\sigma$ can be regarded as constant up to 100 atmos. pressure. The square of the refractive index for $\lambda = 546\ \mu\mu$ is larger than the dielectric constant for infinitely long waves, but the difference between the two quantities is small. [See also Abstracts Nos. 1625, 2045 (1905).] G. E. A.

1566. *Production and Measurement of High Voltages.* **H. Lohmann.** (Ann. d. Physik, 22. 5. pp. 1008–1016, May 2, 1907.)—The author commutes from parallel to series by means of the arrangement shown in the diagram,

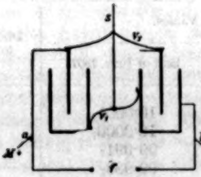


Fig. 1.

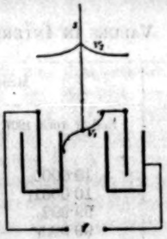


Fig. 2.

where *s* is an insulating bar with attachments serving to connect the two Leyden jars in parallel, with an influence machine connected at *a* and *b*, or in series on raising *s*. The author determines the transformation ratio, which is slightly less than the number of jars employed, and thus obtains a scale of sparking lengths for the higher potentials. E. E. F.

1567. *Metallic Resistance at very High and very Low Temperatures.* **G. Niccolai.** (Accad. Lincei, Atti, 16. pp. 757–766, May 5, 1907.)—This first paper deals with the resistivity of silver, which was measured at temperatures ranging continuously from −189° to +400°. The resistance and temperature curve is practically a straight line, with a very slight concavity towards the axis of temperatures, which it appears to intersect near −270° C. Some of the resistivities determined are given below, in absolute electromagnetic units :—

−189·0°	417	49·8°	1,798
−151·3	639	74·7	1,945
−100·2	918	101·0	2,104
− 49·9	1,220	174·8	2,538
+ 0·2	1,507	250·8	2,976
12·0	1,576	325·7	3,402
25·0	1,654	400·2	3,800

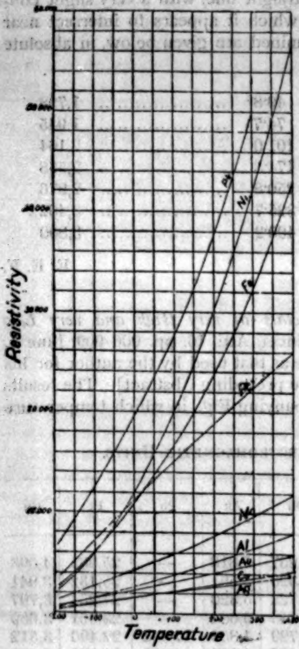
[See also next Abstract.] E. E. F.

1568. *Resistivity of Certain Pure Metals at very High and very Low Temperatures.* **G. Niccolai.** (Accad. Lincei, Atti, 16. pp. 906–909, June 1, 1907.)—The method employed is the same as that used by the author for his investigation of the resistivity of silver [see preceding Abstract]. The results are set forth in the table and the accompanying Fig., in which temperature is plotted against resistivity ; the latter in absolute electromagnetic units. An inspection of the curves in the Fig. shows that though these do not all

RESISTIVITY IN ABSOLUTE ELECTROMAGNETIC UNITS.

Temperature, deg. C.	Al	Ag	Fe	Mg	Ni	Au	Pb	Pt	Cu
400°	7,991	3,772	43,345	11,893	57,257	5,818	—	25,985	4,093
375	7,638	3,642	40,583	11,285	53,390	5,561	—	25,132	3,941
350	7,274	3,501	37,877	10,672	49,722	5,320	—	24,254	3,797
325	6,917	3,377	35,235	10,080	46,243	5,084	—	23,361	3,659
300	6,559	3,240	32,781	9,536	42,729	4,858	49,932	22,490	3,512
275	6,204	3,094	30,357	9,002	39,480	4,623	46,897	21,572	3,322
250	5,850	2,956	28,196	8,508	36,352	4,402	43,814	20,648	3,207
225	5,518	2,819	26,000	8,031	33,337	4,178	40,953	19,753	3,045
200	5,172	2,676	23,928	7,576	30,464	3,956	38,047	18,885	2,888
175	4,827	2,531	21,904	7,132	27,688	3,745	35,322	17,927	2,730
150	4,496	2,385	20,012	6,735	25,025	3,529	32,617	17,032	2,565
125	4,192	2,242	18,235	6,318	22,514	3,317	30,151	16,058	2,403
100	3,858	2,097	16,630	5,915	20,207	3,102	27,844	15,102	2,249
75	3,562	1,946	15,022	5,507	17,946	2,891	25,686	14,124	2,083
50	3,237	1,798	13,504	5,069	15,723	2,675	23,663	13,146	1,921
25	2,925	1,653	12,063	4,700	13,808	2,462	22,047	12,182	1,759
0	2,618	1,505	10,681	4,312	12,005	2,245	19,803	11,193	1,577
− 25	2,321	1,350	9,368	3,894	10,257	2,029	17,958	10,234	1,418
− 50	2,067	1,223	8,147	3,491	8,825	1,818	16,190	9,248	1,251
− 75	1,782	1,079	6,973	3,105	7,352	1,607	14,372	8,207	1,057
−100	1,535	916	5,929	2,643	6,049	1,400	12,610	7,212	904
−125	1,282	765	4,962	2,300	4,866	1,191	10,975	6,218	733
−150	1,038	642	3,988	1,907	3,748	992	9,253	5,200	558
−175	795	496	3,091	1,471	2,703	795	7,624	4,192	391
−189	641	419	2,653	1,275	2,186	688	6,648	3,580	302

pass through the ordinate zero at the absolute zero of temperature, the resistivities are in all cases extremely small. In the case of copper the resistivity should apparently be nil at —201° C., very considerably below the absolute zero. The metals apparently are divisible into two types, viz., iron and nickel, in which the temperature-coefficient increases with rise of temperature; and silver and platinum, on the other hand, in which the coefficient diminishes as the temperature increases. In the first type, the resistivity of nickel at +400° C. is more than 26 times that at —189° C.; for iron more than 16 times. For copper, aluminium, and platinum (second type) the resistivity is over 12, 12, and over 7 times, respectively, the resistivity at —189°. The points of intersection of the curves also are of interest. Thus with copper and silver, at —70° C.; above this point silver has the lower resistivity, but below it copper has the higher conductivity. Similarly with iron and platinum, at 25° C.; above this point the resistivity of iron rapidly rises so that it is 5/3 that of platinum at +400° C.; below 25° iron is the better conductor. Finally, if the law of variation of resistance for the metals Pt, Fe, and Ni remains the same down to the absolute zero of temperature, the curve for Pt will show other points of intersection, in two places, with Fe and Ni. L. H. W.



1569. *Effect of Frequency on Resistance and Inductance of Coils.* **L. Cohen.** (Phys. Rev. 25. pp. 143–144, Aug., 1907. Paper read before the Amer. Physical Soc.)—Wien, Sommerfeld, and others have obtained formulæ for the resistance and inductance of coils carrying high-frequency currents. The formulæ, however, do not agree well with experiment. The author attacks the problem by a novel method, and obtains a formula giving results which agree very satisfactorily with the experimental results obtained by Wien. The author's theory shows that the increase in the resistance is proportional to the radius and the pitch of the coil, the conductivity and diam. of the wire, and the frequency of the alternating current flowing through it. The final formula for the resistance of the coil is given in the form of a rapidly converging series. A. R.

1570. *Production of High-tension Practically Constant (Pertinacious) Currents.* **O. M. Corbino.** (Accad. Lincei, Atti, 16. pp. 957–962, June 16, 1907.)—The author describes an arrangement by means of which high-voltage, nearly constant unidirectional currents can be obtained from a Ruhmkorff coil. The coil, which is preferably of small size, is operated with a Wehnelt break; the secondary circuit includes a spark-gap and a non-inductive resistance r, which latter is shunted by a condenser of capacity C. For not too small or large spark-gaps the secondary current is unidirectional, and for suitable values of C and r, which are arrived at in the theoretical part of the paper, the succession of unilateral currents charging up the condenser gives rise to a "pertinacious" current of which the total relative variation is only 1 in 2,000; it hence may be regarded as practically constant. The coil employed was one capable of giving a spark a few mm. in length. The primary was provided with a large additional self-induction for starting purposes; the applied voltage was 76 volts, the spark-gap 2 mm. The p.d. across the condenser was 1,200 volts with a useful current of about 25 milliamps. Using two Ruhmer condensers in place of the paraffined paper ones, and the aluminium condensers of the first experiments, a p.d. across the condenser was 6,000 volts; and with a 15-cm. spark-coil a current of 15 milliamps. was obtained. L. H. W.

1571. *A Standard of Mutual Inductance.* **A. Campbell.** (Roy. Soc., Proc. Ser. A. 79. pp. 428–435, Aug. 2, 1907.)—The standard described consists of two equal coaxial helical coils for the primary, and a coaxial circular coil as secondary placed midway between them. The mean radius of the secondary coil is so chosen that its windings are in a very feeble part of the field due to the current in the primary coils. Hence the sum of the linkages of the magnetic flux in the neighbourhood of the secondary windings is only a small fraction of the total linkages, and so any errors of measurement in the dimensions or position of the secondary coil have little effect on the calculated mutual inductance. In the actual standard being constructed at the National Physical Laboratory the primary consists of two coaxial helical coils wound on a marble cylinder of 30 cm. diam. The secondary coil has a rectangular cross-section and a mean diam. of 43·8 cm. The author gives diagrams showing how the mutual inductance varies as the secondary coil is moved about, and discusses the elliptic integral formulæ. The principle employed is of general application, and is useful in other practical problems. A. R.

1572. *Throw of a Ballistic Galvanometer.* **F. Wenner.** (Phys. Rev. 25. pp. 139–140, Aug., 1907. Abstract of paper read before the Amer. Physical Soc., April 19–20, 1907.)—The case considered is that of the throw produced when a ballistic galvanometer is connected in series with a condenser and the condenser charged. The galvanometer is of the moving-coil type with radial field, and the motion is undamped. The formula arrived at shows that the time of charge has but little effect on the throw except when the period of the coil, or the ratio of the period of the coil to the product of the resistance and capacity, is small. Experiments with large capacities and variations of the resistance sufficient to change the throw 20 per cent. gave results in fair agreement with the calculated values. A. R.

1573. *Multiple-reflection Synchronoscope.* **H. Abraham.** (Comptes Rendus, 145. pp. 174–175, July 16, 1907.)—The moving part is a small equilateral prism of glass revolving on its axis, and driven by a synchronous motor. This motor, which has only to overcome a very small resistance, may consist of a simple wheel with iron teeth passing an electromagnet. The prism, which serves as a revolving mirror, operates by total reflection. If three or four images per sec. are required, the total reflection forward may be used, and the instrument may be used for direct vision. If a persistent image on a screen is wanted, it is better to use a backward total reflection and auxiliary mirrors. These auxiliary mirrors are placed so as to throw the light on the same spot of the screen. In this manner each beam reflected by the prism is split up into, say, four beams, so that there are 12 flashes for each revolution of the prism. E. E. F.

1574. *Force on a Conductor in a Magnetic Field.* **R. A. Porter.** (Science, 26. pp. 53–56, July 12, 1907.)—Description of an apparatus designed to verify Ampère's laws with respect to the mutual action of conductors conveying currents. A field is obtained by using a **C**-shaped cast-iron cylinder as the core of an electromagnet. The force acting on the conductor is measured by the elongation produced in the spring of a balance of the Linebarger type. The apparatus was devised for the use of students, and gives the force directly in terms of quantities already familiar. J. J. S.

ALTERNATING CURRENTS AND MAGNETISM.

1575. *Crystal Rectifiers for Alternating Currents and Electric Oscillations.* **G. W. Pierce.** (Phys. Rev. 25. pp. 31–60, July, 1907. Jefferson Phys. Lab., Harvard Univ.)—The author has investigated the nature of the effect produced by currents through the carborundum detector of Dunwoody [Abstract No. 1789 (1906) and U.S. Pat. 837,616]. The examination was made by means of the current-voltage curve and the method of plotting this on both sides of the origin, as employed by Brandes for demonstrating the suitability of a material for use as a detector of oscillations [Abstract No. 2078 (1906)]. It is found that the asymmetry of the curve is very marked, indicating that carborundum is unilaterally conductive. In one specimen, with under 10 volts applied, the current in one direction is 100 times the current in the reverse direction. With other specimens platinised on one side the current at about 30 volts was found to be over 500 times, and even 4,000 times, as great as in the reverse direction. The efficiency of rectification decreases (from 69 to 44 per cent.) as the current increases. Platinising the crystal lowers the resistance, and also the efficiency of rectification, but the *excess* of one current over that in the reverse direction is much greater. An oscillogram is given showing the distortion of the current wave by the carborundum. It is then shown that this unilateral property can be employed for the measurement of alternating currents, with the aid of a direct-current milliammeter, a calibration curve of a crystal used as alternating-current voltmeter being given. For telephonic currents the arrangement is also effective. As regards the action of oscillations, which is also noticeable when no external e.m.f. is applied, the author considers that this is due to the unilateral conductivity, and that heat is a negligible factor in the process [compare de Forest and Pickard, Abstracts Nos. 1789 (1906) and 96B (1907)]. The temperature-coefficient is found to be 2·06 and 1·52 per cent. per 1° C. for current in the two directions. The asymmetry of the substances investigated by Braun is in no case as great as with carborundum. Some other crystals have, however, been found to be more sensitive as rectifiers than even carborundum. L. H. W.

1576. *Magnetic Declination during Total Solar Eclipse.* **C. Nordmann.** (Terrestrial Magnetism, 12. pp. 15–26, March, 1907. From the French.)—

During the total solar eclipse of Aug. 30, 1905, at Philippeville, continuous registrations of declination and horizontal intensity were obtained. The instruments were installed in a casemate permitting of excellent temperature control (daily variation less than 0·1° C.). Comparing the declination curves for the eclipse day with others obtained during the period Aug. 14–Sept. 20, it is found that (1) the elongation of the needle to the west of equilibrium position during the whole course of the eclipse was notably less than its mean elongation. (2) None of the other curves recorded at Philippeville during the above period show this peculiarity. (3) At the exact moment of totality, corresponding to the usual max. elongation to the west, there is shown a well-accentuated minimum. The records of similar observations at Burgos, Tortosa, Poisy, and Stonyhurst were next carefully examined, and it was found that, except for slight variations, all the prominent sinuosities were identical on each curve, and, further, they were all synchronous, *i.e.*, produced at the same physical instant. Taking the whole of the curves and eliminating the common features by subtracting the ordinates for each point, a series of values were obtained representing differences of perturbation between each station and Philippeville. On plotting these residuals it was at once evident that they represented a real phenomenon dependent directly on the eclipse. Taking one curve, Burgos minus Philippeville, for instance, the curve rises unmistakably to attain its maximum value at the precise time of totality at Burgos; then it descends very rapidly, and having passed through the initial value, reaches a minimum which coincides with the moment of totality at Philippeville, rising again finally to its initial value. It follows, therefore, that the effect of the eclipse is to cause a deflection of the needle to the east. The symmetry of the minimum and maximum of the curve proves that the magnetic effect accompanying the eclipse was of sensibly equal magnitude at the two stations at the moments of their respective totalities. The deflection at Philippeville amounted to about 3′ to the east, whereas the needle at the eclipse time should, according to the normal daily variation, be about 5′ to the west of its mean position. The author proposes to explain the phenomenon by the direct action of the solar heat on the atmosphere. The upper air currents will be altered in conductivity when they are immersed in the shadow, and this variation crossing the earth's magnetic field may induce sufficient e.m.f. to influence the needle. The fact that the daily variation does follow the insolation almost exactly lends support to this view. On this idea the effect of the total eclipse is not to produce an actual deflection to the east, but to diminish the causation factor producing the westerly daily variation. C. P. B.

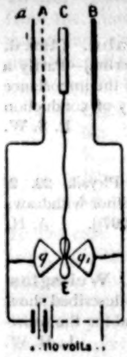
1577. *Short-period Pulsations in Terrestrial Magnetic Field.* **H. Ebert.** (K. Bayer. Akad. München, Ber., 1906. Terrestrial Magnetism, 12. pp. 1–14, March, 1907. Translation.)—For a considerable time general interest has been aroused by the regular oscillations of short period in the earth's magnetic force, which at times of magnetic disturbances as well as at times of perfect magnetic calm appear as short waves in the magnetograph traces. These have been noted in all magnetic work for many years back, the work of Lamont, Balfour Stewart (1861), and Kohlrausch (1897) being specially mentioned, the last-named stating that the oscillations are usually of the order of 12 sec. period and amplitude of $4\gamma = 0{\cdot}00004$ c.g.s. Eschenhagen improved the study of them by increasing the rate of the magnetograph recording cylinder to 1 mm. = 15 sec. in place of the 1 mm. = 180 sec. formerly employed. W. van Bemmelen has established that the vertical component is always much less strongly influenced by these pulsations than the horizontal component. Finding that the inertia of the usual galvanometer suspension was too great for recording such rapid oscillations, a modification of the "chord" instrument was employed with success. The vertical force changes were studied by means of an inductive area made by a cable laid on the ground, enclosing about 52,640 sq. m. The ends of the cable were placed in circuit with a very thin platinum or gold fibre stretched in a magnetic field (Einthoven). Rapid oscillations of only a few seconds' period were frequently observed. C. P. B.

1578. *Effect of Stress on Magnetisation and the Change of Elastic Constants by Magnetisation.* **K. Honda** and **T. Terada.** (Phil. Mag. 14. pp. 65–115, July, 1907. From the Journ. Coll. Sci., Tokyo.)—As the previous series of tests had shown [Abstract No. 477 (1907)] that the change of elastic constant with magnetisation differs more or less for different orders of applying the stress and the field, a new series is undertaken in which are investigated the change of magnetisation by applying successive stresses under constant fields, and the magnetisation when the field is applied under different constant stresses. Rensing and Cantone have already done work in this direction in the case of iron and nickel, but the present is a more extended research, the specimens examined being Swedish iron, tungsten steel, nickel, and three nickel-steels. In Swedish iron and tungsten steel, the change of magnetisation with load increases up to a moderate field and then decreases with it. With constant load the magnetisation increases rapidly with low fields. In these two metals the final magnetisation is considerably affected by the order of magnetising and straining. Nickel has already been studied by several physicists; in the present case several effects of stress on magnetisation are studied with the same specimen over a wide range of field and with special attention to hysteresis. The nickel-steels examined contained 28·74, 50·72, and 70·32 per cent. Ni; with them the change of magnetisation with tension does not differ much with the different orders of straining and magnetising; on the other hand, the change of magnetisation by twist differs sometimes in a considerable degree for the different orders. In considering the reciprocal relations, three chief ones, connecting field strength and magnetisation with stress and strain constants, are taken, and tested by means of the material furnished by the two long series of experiments. From this it appears that, among all the specimens, nickel affords the best evidence in favour of the theories thus tested. The paper is profusely illustrated with tables and curves. G. E. A.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

1579. *Ionic Penetration of Electrolytes across Colloidal Salts.* **H. Iscovesco** and **A. Matza.** (Comptes Rendus de la Soc. de Biologie, Feb. 8, 1907. Archives d'Él. Médicale, 15. pp. 427–429, June 10, 1907.)—On allowing warm gelatine solution containing 0·7 per cent. of sodium chloride to solidify in a U-tube so as to fill the bend, filling the two limbs of the tube with a solution of an electrolyte and passing a current of 6–8 milliamps. through the liquid, it is found that only one of the ions into which the electrolyte dissociates penetrates the gelatine. The penetrating ion is MnO_4 in the case of potassium permanganate and Cu in that of copper sulphate; in the former case manganese dioxide is precipitated, and in the latter cupric chloride is formed. The application of a kathode steeped in a salt solution to the skin for the purpose of introducing the salt into the organism, hence cannot be regarded as efficacious. T. H. P.

1580. *Villard's Radio-sclerometer.* (Ind. Elect. 16. pp. 207–208, May 10, 1907.)—The apparatus described which was exhibited at the French Physical Society's soirée, is for the purpose of determining the penetrability of metal sheets for the Röntgen rays. An electrometer has two quadrants *q*, *q*, connected to a source of constant potential, being also connected to two plates A and B (see Fig.); A being a grid structure. Between A and B a plate C is placed and connected to the needle E. In the normal state, with no rays acting, the needle is stationary, its potential lying midway between A and B. When, however, Röntgen rays are allowed to fall on A (direct charging of A being prevented by means of a thin Al plate (*a*) interposed) the rays pass to a greater or less extent through C, according to the penetrability of the latter. The space between A and C is, as a result, more strongly ionised than that between C and B, and consequently the potential of C approaches that of A; and the needle takes up a new position. The change of deflection is a measure of the penetrability of C. In this way a radiochromometric scale can be constructed. L. H. W.



REFERENCES.

1581. *Properties of Electrons.* **S. Sheldon.** (Rev. Électrique, 8. pp. 155–159, Sept. 15, 1907. Amer. Inst. Elect. Engin., Proc. 26. pp. 651–682, May, 1907. Presidential Address.)

1582. *Report to British Association of Committee on Practical Standards for Electrical Measurements.* (Electrician, 59. pp. 716–718, Aug. 16, 1907. Leicester Meeting, Aug., 1907.)—Appendices by F. E. Smith deal with the subjects: I. The Ohm (absolute unit), II. The International Ampere, and III. The Preparation of the Weston (cadmium) Standard Cell. [Full papers to appear shortly.]

1583. *Atmospheric Electricity on the Eastern Mole near Swinemünde.* **G. Lüdeling.** (Meteorolog. Inst. Berlin, Veröff. p. 12, 1905. Abstract by P. H. Dike in Terrestrial Magnetism, 12. p. 40, March, 1907.)—The mole extends 2 km. into the Baltic. The observations were made in Aug. and Sept., 1904, in continuation of previous work in the Baltic and Heligoland, chiefly in order to test the suitability of the Benndorf recording electrometer at field stations under difficult conditions. The other instruments used were of the Elster-Geitel and Ebert types. The electrometer proved highly satisfactory; but the calomel battery was replaced by a Chauveau battery, zinc and copper in magnesium sulphate. H. B.

1584. *Behaviour of Certain Crookes' Tubes.* **A. Broca** and **Turchini.** (Archives d'Él. Médicale, 15. p. 602; Discussion, p. 603, Aug. 10, 1907. Paper read before the Assoc. franç. pour l'avancement des Sciences, Rheims, Aug. 1–6, 1907.)—The authors discuss certain peculiarities observed with tubes having osmo-regulators and the glass of which was of a very high insulating quality. L. H. W.

1585. *Hot-wire Instrument for Small Currents.* **G. Berndt.** (Deutsch. Phys. Gesell., Verh. 9. 12. pp. 243–250, June 30, 1907. Phys. Laborat. des Polytechnikums, Cöthen.)—The author describes experiments made with hot-wire apparatus similar to that of Kempf-Hartmann [Abstract No. 472 (1902)] except that the sag is read off by means of a microscope. Its application as vacuum meter, as previously used by Voege [Abstract No. 1434 (1906)], is described, but the smallest detectable current is about 0·1 amp. with the present instrument [compare Abstract No. 1113 (1906)]. L. H. W.

1586. *Adiabatic and Isothermal Hall-effect in Bismuth.* **H. Zahn.** (Ann. d. Physik, 23. 1. pp. 131–147, May 28, 1907. Phys. Inst. d. Univ., Berlin.)—Partly a criticism of a paper by Gans [Abstract No. 1443 (1906)]. Because of the importance of the transversal effects as a means of testing the electron theory of conduction these constants have been redetermined. R. S. W.

1587. *Theory of Permanent Magnets.* **R. Gans.** (Ann. d. Physik, 23. 2. pp. 399–400, June 13, 1907.)—A brief communication in which the author withdraws some of the views previously expressed by him [Abstract No. 711 (1907)]. A. H.

1588. *Electric Capacity of Nerves.* **N. Cybulski** and **W. Weissglas.** (Acad. Sci. Cracovie, Bull. 6. pp. 476–496, June, 1906.)—Experiments described show that *under certain conditions* a nerve has capacity. The values found for the resistance and capacity are given. L. H. W.

1589. *New Form of Radiometer.* **W. W. Coblentz.** (Bureau of Standards, Bull. 2. pp. 479–483, Dec., 1906.)—[See Abstract No. 308 (1907).] Greater sensitiveness is obtained by placing the whole in a vacuum.

1590. *Disturbance of Compass by Currents in Ship's Hull.* **C. Arldt.** (Elektrotechn. Zeitschr. 27. pp. 1085–1089, Nov. 22, 1906. Elect. Rev. 60. p. 875, May 31, 1907.)—Further considerations [see Abstracts Nos. 583, 1452 (1906)].

1591. *Faults Inherent in Large Radiographs.* **Klynens** and **Poirier.** (Ann. de la Soc. Méd.-chir. d'Anvers, Oct., 1906. Archives d'Él. Médicale, 15. pp. 298–305, April 25, 1907.)—The author discusses the imperfections of the radiograph which are largely due to the fact that they are really silhouettes. He emphasises the importance of having the object as close to the plate as possible. The use of small plates is recommended wherever possible as being more convenient, cheaper, and more easily exposed and examined. H. W. P. Y.

1592. *Robison Ball-ended Magnets.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 14. pp. 185–189, June 13, 1907.)—A method of mounting a Robison magnet to serve as a magnetometer. [See also Abstract No. 1069 (1903).] A. W.

1593. *Temperature Control of the Cheltenham Magnetic Observatory U.S. Coast and Geodetic Survey.* **J. E. Burbank.** (Phys. Rev. 25. pp. 115–122, Aug., 1907.)—Curves of monthly mean temperatures and relative humidity are included.

1594. *Recent Results of Terrestrial Magnetic Observations.* **L. A. Bauer.** (Technology Quarterly, 20. pp. 170–186, June, 1907.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1595. *Densities of the Alkali Metals.* **T. W. Richards** and **F. N. Brink.** (Amer. Chem. Soc., Journ. 29. pp. 117–127, Feb., 1907. Contribution from the Chem. Lab. of Harvard College.)—As a result of a large range of concordant determinations the densities and atomic volumes of the alkali metals were found to be at 20°.

	Density.	At. Wt.	At. Vol. (Ag = 107·93).
Li	0·534	7·0	13·1
Na	0.9712	23·008	23·70
K	0·8621	39·114	45·38
Rb	1·532	85·48	55·8
Cs	1·87	133·8	71·0

In the case of sodium, potassium, and rubidium the floating method was used, paraffin and carbon tetrachloride being used to prepare the liquid mixture. No mixture could be found in which lithium would not float, and in this case, therefore, weighed pieces of platinum wire were wound round weighed pieces of lithium, and the combinations were investigated as if they had been pieces of heavier metal. Caesium, on the other hand, could not be made to float, and its density was determined by displacement of paraffin. The density of a liquid alloy of 39·9 per cent. K, 60·1 per cent. Na was found to be 0·919, or about 1 per cent. less than the mean value, 0·928, calculated from the densities of the two constituent solid metals. T. M. L.

1596. *Chemical Changes induced in Gases by Ultra-violet Light.* **D. L. Chapman, S. Chadwick,** and **J. E. Ramsbottom.** (Chem. Soc., Journ. 91. pp. 942–952, May, 1907.)—With the aid of apparatus specially designed for the examination of the chemical changes brought about in gases by the influence of the light emitted from a mercury lamp, the authors study the conversion of oxygen into ozone, the interaction of carbon monoxide and oxygen and the decomposition of carbon dioxide with a view to ascertaining the effect, in each case, of the presence of varying amounts of water vapour; the alteration of pressure is used to follow the course of the change. With mixtures of carbon monoxide and oxygen, the velocity of change of pressure is independent of the content of water vapour, but the yield of carbon dioxide increases and that of ozone decreases with increase of moisture; since carbon monoxide is not affected by ultra-violet light, it is probable that the first chemical effect of the light is the decomposition of the oxygen molecules into atoms, which then combine either with each other to give ozone or with carbon monoxide. A noteworthy observation is the stability of ozone towards ultra-violet light in presence of oxides of carbon. The decomposition of carbon dioxide by ultra-violet light takes place only when the gas is quite dry, its amount being about 3 per cent. at ordinary pressure and 46 per cent. at 36 mm. pressure. These results show that, in a photochemical reaction, the position of equilibrium is not independent of the catalyst, so that the latter (moisture) exerts a marked influence in determining the mode of distribution of the energy amongst the molecules of the reacting substances. T. H. P.

1597. *Borides of Nickel and Cobalt.* **B. du Jassonneix.** (Comptes Rendus, 145. pp. 240–241, July 22, 1907.)—As in the case of iron [Abstract No. 1419 (1907)], the author finds that by heating together, in the electric furnace in a current of hydrogen, mixtures of B with Ni and Co, definite compounds are obtained corresponding to the formulæ Ni_2B, and Co_2B, the first-named crystallising in small grey needles of a density at 20° of 7·9, and the second in very small acicular crystals of a pale yellow colour, having the density at 20° of 8·0. Non-crystalline alloys have also been obtained containing quantities of boron corresponding to the compounds NiB_2, and CoB_2, which represent the limits of direct combination of boron with these metals. W. H. Si.

1598. *New Silicide of Platinum.* **P. Lebeau** and **A. Novitzky.** (Comptes Rendus, 145. pp. 241–243, July 22, 1907.)—Finely-divided silica and spongy platinum heated together, in equal proportions, in either a Forquignon and Leclerc furnace or an electric resistance furnace, yield, on extraction with a dilute solution of potash, a residue having a composition corresponding to the formula SiPt. Crystallised from molten silver the compound is obtained in very small prisms having a density at 15° C. of 11·63, and melting at about 1,100° C. On warming with tin it decomposes, forming $SiPt_2$.

W. H. Si.

1599. *Copper-Nickel and Copper-Gold Alloys. Electrical Conductivity of Alloys.* **N. S. Kurnakow** and **S. F. Żemcżużny.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 6. pp. 894–896, 1906. Zeitschr. Anorg. Chem. 54. 2. pp. 149–169, June 17, 1907.)—Gives the authors' determinations of the solidification curves and microstructure of the Cu-Ni and Cu-Au alloys. In each case a continuous series of mixed crystals was found. Although in the case of Cu-Au alloys this result is not in agreement with those of previous investigations, yet published data of the conductivity of both these series of alloys are in complete accord with the authors' results. As is known, a continuous series of solid solutions gives an electrical conductivity curve which is convex downwards. From other published data it is deduced that metals of the eighth group of the periodic system show an exceptional tendency to form solid solutions. In the case of limited solubility, the portions of the curve corresponding to mixtures are straight lines. F. R.

1600. *Some Platinum Alloys.* **F. Doerinckel.** (Zeitschr. Anorg. Chem. 54. 4. pp. 333–366, July 31, 1907. Metallog. Communication from the Inst. f. anorg. Chemie d. Univ., Göttingen.)—From a thermal and microscopic study of the series of alloys it is concluded that Pt forms uninterrupted series of mixed crystals with Au and with Cu, but with Ag only up to 48 per cent. Pt. Pt forms several compounds with Pb and Sn. The existence of PtPb is established, but the formulæ of probable poorer and richer compounds could not be ascertained. Pt_3Sn and PtSn are given as established, Pt_2Sn_3 and Pt_2Sn_8 as probable. Pt_2Sn_3 exists in two different forms having a transformation-temperature of 788°. The Pt alloys are compared with the corresponding Pd alloys. It is considered that Tammann's rule, which states that an element either forms compounds with all or with none of the elements of any particular group of the periodic system, is confirmed by the constitution of these Pt alloys, as well as by that of the Pd alloys. F. R.

1601. *Tantalum Steels.* **L. Guillet.** (Comptes Rendus, 145. pp. 827–829, July 29, 1907.)—The author gives results of tests and examination of four steels containing from 0·12 to 0·18 per cent. C, and 0·09 to 1·05 per cent. Ta. Mn and Si were fairly uniform, Mn being 0·28 per cent. and less. In the normal state the steels were pearlitic and practically little modified in structure by the presence of Ta. The tensile strengths ranged from 41·5 to 47·8 kg./mm.^{2}, elastic limits 29·8 to 31·5 kg. mm.^{2}, and elongations from 33 to 28 per cent. with increasing Ta; the resistance to shock is in all cases high—28 to 20 kg./mm.^{2}. This effect on the properties of steel can readily be produced by the addition of other metals than Ta. The critical points between 600° and 675° are not well marked. The transformations at 770°–790° in heating and 730°–750° in cooling, however, are exceptionally well marked. Quenched from 875°, the effect of Ta is a little more apparent; it appears to be almost independent of the amount of Ta, and of the same kind as in the normalised samples. On the whole it is concluded that the rumours as to the remarkable qualities to be expected of tantalum steels are unfounded. F. R.

1602. *Viscosity of Liquid Mixtures.* **A. E. Dunstan** and **R. W. Wilson.** (Chem. Soc., Journ. 91. pp. 83–91, Jan., 1907.)—I. A curve is given for the viscosity of mixtures of sulphuric acid and water. Taking the viscosity of water as 0·00891, that of sulphuric acid rises to a maximum at 85 per cent., sinks again to 96 per cent. and rises again to 100 per cent. as follows :—

Percentage	0	15·699	51·640	80·243	85·070	95·723	97·513	99·924
Viscosity	0·00891	0·05851	0·15370	0·78099	0·94794	0·83255	0·85761	1·06160

The curve indicates the very distinct maximum corresponding with the composition H_2SO_4, H_2O, but the high degree of viscosity is taken to indicate that the actual compound formed is a complex polymeride of the simple hydrate. II. *Connection between Molecular Weight and Angle between Tangent to Curve and Axis of Viscosity.*—If α is the angle at which the viscosity-concentration curves intersect the axis of concentration, it has been found that in a considerable number of cases the product $M\alpha$ (where $M =$ mol. wt. of solute) = a constant, the numerical value of which is about 8,000 for benzene as solvent. Alcoholic solutions gives less regular results. III. *Connection between Molecular Weight and Viscosity.*—In a large number of cases the ratio of viscosity to molecular weight is constant, but hydroxylated liquids give values which may be nearly 100 times greater. IV. *Relation between Molecular Weight and Viscosity of Series of Compounds.*—The logarithm of the viscosity plotted against the molecular weight exhibits a linear relationship in the case of the alkyl iodides, formates, and acetates, the paraffins and the ketones; these curves have practically the same slope in each series. In the case of the alcohols, however, the curve shows a minimum at methyl alcohol, and in the case of the acids a minimum at propionic acid; these curves can, however, be straightened out by assuming the formula $(H_2O)_3$ for water and the formula $(CH_2O_2)_2$ for formic acid. Similar considerations indicate that benzene is polymerised to the apparent molecular weight 110. T. M. L.

1603. *Determination of the Internal Friction of certain Fused Salts.* **R. Lorenz** and **H. T. Kalmus.** (Zeitschr. Phys. Chem. 59. pp. 244–251, April 30, 1907. Laborat. f. phys. Chemie u. Elektrochem. d. eidg. Polytechnikums, Zürich, 1905–1906.)—From measurements of the viscosities of sodium and potassium nitrates, potassium dichromate, lead chloride and bromide at various temperatures from their melting-points upwards, it is found that the product of viscosity and conductivity [compare Abstract No. 1271 (1907)] usually diminishes as the temperature rises; this result is analogous with that obtained with aqueous solutions. The decrease of the product for a rise of 100° C. is about 4·5 per cent. for sodium or potassium nitrate, 24 per cent. for lead chloride, and 22 per cent. for lead bromide.

T. H. P.

1604. *Viscosity of Liquid Crystals.* **L. Puccianti.** (Accad. Lincei, Atti, 16. pp. 754–757, May 5, 1907).—Studies the viscosity of certain substances which form liquid crystals of turbid appearance or limpid liquids, according to the temperature. There is a distinct increase in viscosity on decrystallation, and not a diminution, as might have been expected. In cholesteryl benzoate this increase of viscosity cannot be very clearly traced. But in *p*-azoxyanisol there is a distinct jump in the viscosity at the point of transformation, it being turbid at 134 with a viscosity 1·37 times that of freezing water, and limpid at 135 with a viscosity 1·73. This, however, declines again slightly on further heating. In *p*-azoxyphenethol this upward jump on liquefaction is still more marked, as may be seen from the following series:—

Temperature.	Viscosity.	
160°	0·74	turbid
165	0·765	,,
166	0·817	,,
Transformation.		
167	1·35	limpid.
170	1·15	,,

Lehmann's conception of an ordered relative motion of the crystal-forming molecules is quite thinkable in connection with a higher mobility in this state than in the ordinary liquid state.

E. E. F.

1605. *Mobility of Ions in Water.* **K. Drucker.** (Zeitschr. Elektrochem. 13. pp. 81–83, March 8, 1907.)—It has been known for some time that the value 318 for the mobility of the hydrogen ion in water at 18° is probably too high, and that a number about 312 is in many respects to be preferred. The author has tabulated the experimental data for the limiting conductivity of hydrochloric, nitric, and sulphuric acids, and with the help of the transport numbers deduces for the mobility of the hydrogen ion the values—

HCl	312·7, 312·3, 315·3
HNO_3	310·7
H_2SO_4	313·7

whilst picric acid by another method gives the value 312. By applying similar considerations the following values are deduced for the mobilities of the more important ions at 18°—

K	64·4 ± 0·08	Cl	65·2 ± 0·13
Na	42·7 ± 0·06	NO	62·3 ± 0·26
Ag	54·0 ± 0·0	$\frac{1}{2}SO_4$	66·7 ± 0·26
H	313·0 ± 0·26		

T. M. L.